ISSN: 2250-2823

HortFlora Research Spectrum

JOURNAL

Volume 1 (2) April – June 2012

Peer Reviewed Quarterly

BIOSCIENCES & AGRICULTURE ADVANCEMENT SOCIETY
MEERUT

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Editorial Office :
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ISSN: 2250-2823

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HORTFLORA RESEARCH SPECTRUM *ISSN : 2250-2823*
Volume 1(2), April-June, 2012

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HortFlora Research Spectrum, 1(2): 97-102 (2012) ISSN : 2250-2823

ALLELOPATHY: IT'S INTERFACE IN TREE-CROP ASSOCIATION

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ABSTRACT: Combination between tree and crops interacts dynamically and provides multi-faceted aspects of improvement such as increased productivity, enrichment of soil with organic matter and nitrogen, transport of nutrients from lower to the upper layer of soil, conservation of environment, improved microclimate and allelopathy is one amongst them when it comes to combine the both components for sustainable land use and to increase food production. Because these components co-exist simultaneously, their allelopathic compatibility may be decisive to determine the selection of successful tree-crop combination. Mostly trees have negative allelopathic effects on crops, therefore, it is essential to explore that what type of tree-crop interaction will have no or positive allelopathic effects on the companion crops may be combined for beneficial results. As trees remain a part of the agroforestry system for a longer period, and most of them produce a large amount of leaves and litter, their allelochemicals may play an important role in an overall improvement. If the due emphasis is given, allelopathy could play a major role in enhancing the production and productivity in agroforestry systems by having the better understanding about tree-crop combination.

Keywords: *Allelopathy, tree-crop association, allelochemicals, interference.*

The term allelopathy was coined by Molish (16) to include both harmful and beneficial biochemical interaction between all types of plants including micro-organisms. Rice (28) reinforced this definition in first monograph on allelopathy. Allelopathy is an important mechanism of plant interference and is mediated through the addition of chemicals to the plant environment. Muller (18) suggested the term interference of one plant (including micro-organism) on another. However, compared to forest tree species, the agroforestry tree species have been investigated for alleloapthic influences. Although, agroforestry system has a potential to increase yield, it has compete with food crops (Paulino *et al.,* 24). The overall effect of tree on understorey vegetation depends on the balance between their positive (facilitation) and negative (competition) effects (Callaway and Walker, 6). Rafiqul-Hoque *et al.* (27) have shown that certain trees contain higher levels of bioactive chemicals, suggesting a large inhibitory potential (Barnes *et al.,* 3). Allelopathic interaction involves the production and release of chemical substances which can inhibit the growth and the develpoment of the understorey vegetation. Cannell *et al.* (7) argued that agroforestry may increase productivity because trees can capture resource which are underused by crops. Ovalle and Avendano (21) reported that trees increase understorey herbaceous productivity. Allelopathy arises from the releasse of chemicals by one plant species that affect other species in its vicinity, usually to their detriment.

The most formidable problem in managing simultaneous agroforestry in drylands is how to retain the positive effects of tree canopies and roots on soil physical and chemical properties while reducing the negative effects of below-ground competition for limited resources (Ong and Leakey, 20; Schroth, 30).

1. COMPETITION AND ALLELOPATHY

Competition means effect on others in terms of harmfulness, but allelopathic effect may be beneficial or harmful. Allelopathic substances are imprtant factors in competition between crops and trees (Paulino *et al.,* 24). Allelopathic effects are closely associated with competition and it is

Received : 16.3.2012 *Accepted : 10.4.2012*

difficult to eliminate allelopathy from competition studies. Muller (17) has seperated "competition" from "Allelopathy", the former was based on use of resources (nutrients, water and light) which are the limiting factors, whereas the latter involve the production of toxic substances (allelochemicals). Puri and Bangawa (25) have found that neem tree has no adverse effect on the yield of wheat (*Triticum aestivum*) if grown 5 m apart from the main stem. Some studies suggest a direct role of neem allelochemicals in this effect on crop plants. Allelopathy can be defined as chemical interactions between and among both plants and microorganisms *via* releases of biologically active chemical compounds into the environment. The allelopathic potential of certain trees and crop species can influence the growth and distribution of associated trees species and the yield of desired plants. For a tree to be biologically efficient and ecologically effective, it must interfere with other surrounding species. This interference has two primary components: competition and allelopathy. Competition is the control or removal from the common environment of essential resources needed for life. Allelopathy is the addition of materials to the common environment which changes life functions. Allelopathy is the biochemical modification of the environment to enhance tree survival and reproduction Interference is the proper name for individual ecological interactions. The word "competition" is mis-used/over-used to describe species interactions. Rarely is allelopathy isolated or eliminated in competition studies, and so, the combined term "interference" is most accurate to use. Allelopathy is a defensive component of tree interference. The component plant species in agroforestry system depends on the same reserve of growth resources such as light, water and nutrients and hence there will be influence of one component of a system on the performance of the other components as well as system as a whole. These are referred to as tree-crop interactions. These interactions may be positive or negative (Basavaraju and Gururaju, 4). The balance between these positive and negative effects determines the overall effects of the interactions in a given agroforestry combination.

2. ALLELOPATHY IN TREE-CROP INTERACTION

2.1 Effect of Trees on Crops

Trees and crops have been grown together since ancient times. In any system, the trees and the crops may compete for light, water, and nutrients or have complementary needs. When the interactions between the trees and crops are managed well, agroforestry systems, traditional or modern, can outperform sole cropping systems. In most of the cases allelopathic effect are selective and vary with different tree crops (Melkania, 15; Stowe, 31). In general leaves are most potent source of allelochemicals, however, the toxic metabolites are also distributed in all other plants parts in various concentrations. The allelopathic effect may be so striking that competition for resources does not explain why, in plant communities, many species appear to regulate through the production and release one another through the production and release of chemicals attractants, stimulators or inhibitors (Putnam and Tang, 26). Several species are known to have allelopathic effects on other crops, *e.g.,* maize (*Zea mays* L.), wheat (*Triticum aestivum* L.), oats (*Avena sativa* L.), barley (*Hordeum vulgare* L.) as reported by Rice (28). Rafiqul-Hoque *et al.* (27) have shown that certain trees contain higher levels of bioactive chemicals, suggesting a large inhibitory potential (Barnes *et al.* 3). Agroforestry have both tree and crop components. So the situation will be very complex. In case of legumes allelopathic effect of leachates and extracts of *Pinus roxburghii* in Kumaon Himalaya has been recorded. Mimosine toxicity of *Leucaena leucocephala* was observed on green gram *i.e.* inhibitory effect on germination. Various types of trees shows different type of positive and negative effect on crops. A possible allelopathic effect of *Acacia* trees has also been recognized. Other authors have shown a large inhibitory potential in the genus of *Acacia* (Rafiqul-Hoque *et al.,* 27). Autotoxicity is also responsible for the

Table 1. Allelpathic effect of different tree species on agri-horticultural crops.

Tree species	Plant part/soil allelochemicals	Affected crop	Effect
Leucaena leucocepahala	Mimosine	Green gram, Rice	Inhibitory effect on germination and growth
	Mimosine	Rice, rye, lettuce	Inhibitory effect on germination and growth
	Leaf extract	Wheat, maize, pea, mustard	Inhibitory effect on germination
	Soil	Rice	No effect on germination
	Leaf extract	Rice	Inhibitory effect on germination
	Leaf extract	Rice	Stimulatory effect on germination
Acacia tortilis	Leaf ,stem, and soil extract	Pearl millet, sesame, cluster bean, Wheat	Inhibitory effect on germination, growth and yield
Walnut	Field study	Potato, tomato, Alfalfa	Inhibitory effect on growth
	Field study	Potato,maize, turnip	Inhibitory effect on growth
Bamboo	Leaf extract	Groundnut	Inhibitory effect on growth, chlorophyll and protein content
Eucalyptus citridora	Leaf, stem and root extract	Okra, wheat, cowpea, maize	Inhibitory effect on growth
Eucalyptus tereticornis	Leaf, stem and root extract	Sorghum, cowpea, sunflower	Inhibitory effect on germination and growth
Pinus radiata	Leaf extract	Ryegrass, white clover	Inhibitory effect on ryegrass and stimulatory effect on white clover
Pinus roxburghii	Leaf and root leachates, decaying litter, field soil	Black gram, green gram, horse gram, soybean	Both inhibitory and stimulatory effect

inhibition of seed germination and/or delay of seedling growth exhibited by some annuals including corn, *Zea mays* (Martin *et al.,* 13) and wheat, *Triticum aestivum* (Jessop and Stewart, 11). Allelochemicals in soil and their effect on crop plants may be modified by soil moisture, soil temperature and other soil factors (Patrick and Koch, 23). The effects of secondary substances released by these mechanisms can be long lasting (Patric, 22) or quite transitory (Kimber, 12) and can ultimately influence practices like fertility, seeding and crop rotations. The allelopathic effects are selective (Melkania, 14; Stowe, 31) and vary with different trees since these plants will vary in the amount of indigenous secondary metabolites and would release different amounts of the phytotoxins. Harborne (10) proved that higher plants (tree crops) release some phytotoxins into soil, which adversely affect the germination and yield of crops. Such type of tree crop interactions called phytochemical ecology/ecological biochemistry. These are given in Table 1.

2.2 Effect of Trees on Tree

Allelopathy is the chemical modification of a site to facilitate better tree growth, and control ecological volume and essential resources. The proportion of allelopathy within each species interference effect is highly variable depending upon the site, species, and individual. Some trees are rich sources of secondary metabolites (allelochemicals), which play a major role in regulating pattern of vegetation, these chemical

Table 2: Tree species with potential allelopathic activities.

Tree species	Allelochemicals
Leucaena leucocephala	Mimosine
Walnut	Juglone
Azadirachta indica	Azadirachtin
Eucalyptus spp.	1,4- and 1,8-cineole
Guava	Phenolics
Peach	Amygdalin
Mallus domestica	Phlorizin, Quercetin

Table 3: Crop species with potential allelopathic activities.

Crop species	Common name
Allium sativum	Garlic
Avena sativa	Oat
Brassica hirta	White mustard
Brassica juncea	Brown mustard
Cajanus cajan	Pigeon pea
Carthemus tinctorius	Safflower
Cucumis sativus	Cucumber
Glysine max	Soybean
Medicago sativa	Alfalfa
Oryza sativa	Rice
Hordeum vulgare	Barley

imposed a kind of environmental stress on other plants growing in their vicinity. The seedlings of one tree shows positive and negative influence on total volume of seedling of neighbouring tree. The influence of tree seedlings on growth of each started from first year and become powerful in the second year. In case of walnut, tree toxicity is found to other tree plant like, apple, berry. Auto toxicity, a type of intra-specific allelopathy, is a major reason why managed tree ecosystems fail to regenerate, causing replant problems. The allelopathic effects of Eucalyptus have been studied extensively (Del Bajwa and Nazi, 2; Moral and Muller, 8; El-Khawas and Shehata, 9; Sasikumar *et al.,* 29). Phenolic acids and volatile oils released from the leaves, bark and roots of certain Eucalyptus spp. have harmful effects on other plant species (Sasikumar *et al.,* 29). Most reports have focused on the allelopathic effects of litter extracts; those of living root exudates have been less well investigated (Bagavathy and Xavier, 1; Bernhard-Reversat, 5).

2.3 Effect of Crops on Crop

Effect of one crop including micro-organisms on other crop/same crop is called "crop allelopathy". It is well known that crops cultivated in rotation produce higher yield than those of grown in monoculture. It is reported that allelochemicals from alfalfa soil inhibit growth of barley, wheat, radish, and alfalfa. Narwal *et al.* (19) have reported alleloapthic effect on the germination and seedling growth of Indian colza, wheat, barley, lentil, chickpea, etc. and aqueous root extract of soyabean on rape and mustard. A high concentration of phenolic acid in paddy (*Oryza sativa* L.) soils of India and Japan has been reported which found inhibitory to root growth of rice plants. Thus auto toxic effect in oat, maize, rice, sorghum, and wheat have been established.

CONCLUSION

The allelopathic potential of trees and crop can influence the growth and distribution of associated tree species and the yield of desired plants, and allelopathy has been employed successfully in this context. When the trees and crops grown together they interact with each other either inhibiting or stimulating their growth or yield through direct or indirect allelopathic interaction. Thus, it plays an important role in an agroforestry system and it is clear that a better understanding of allelopathy can help in developing more sustainable agroforestry system.

REFERENCES

1. Bagavathy, S. and Xavier, G.S.A. (2007). Effects of aqueous extract of *Eucalyptus globulus* on germination and seedling growth of sorghum. *Allelopathy J.,* **20:** 395–401.
2. Bajwa, R. and Nazi, I. (2005). Allelopathic

effects of *Eucalyptus citriodora* on growth, nodulation and AM colonization of *Vigna radiata* (L.) *Wilczek. Allelopathy J.,* **15:** 237–246.

3. Barnes, R.D., Filer, D.L. and Milton, S.J. (1996). *Acacia karroo.* In: *Tropical Forestry Papers* No. 32. Oxford Forestry Institute, Oxford University.
4. Basavaraju, T.B. and Gururaja, R. (2000). Tree-crop interactions in agroforestry systems: A brief review. *Indian Forester,* **126** (11): 1155-116
5. Bernhard-Reversat, F. (1999). The leaching of *Eucalyptus hybrids* and *Acacia auriculiformis* leaf litter: laboratory experiments on early decomposition and ecological implications in congolese tree plantations. *Applied Soil Eco*., **12**: 251–261
6. Callaway, R.M. and Walker, L.R. (1997). Competition and facilitation: a synthetic approach to interactions in plant communities. *Ecology,* **78:** 1958-1965.
7. Cannell, M.G.R., Van Noordwijk, M. and Ong, C.K. (1996). The central agroforestry hypothesis: the trees must acquire resources that the crop would not otherwise acquire. *Agroforest. Syst*., **34:** 27-31.
8. Del Moral, R. and Muller, C. H. (1969). Fog drip: a mechanism of toxin transport from *Eucalyptus globulus. Bull. Torrey Bot. Club*, **96:** 467–475.
9. El-Khawas, S.A. and Shehata, M.M. (2005). The allelopathic potentialities of *Acacia nilotica* and *Eucalyptus rostrata* on Monocot (*Zea mays* L.) and Dicot (*Phaseolus vulgaris* L.) *Plant Biotech*. **4:** 23–34.
10. Harborne, J.B. (1977). *Introduction to Ecological Biochemistry.* Academic Press, New York.
11. Jessop, R.S. and Stewart, L.W. (1983). Effect of crop residues, soil type and temperature on emergence and early growth of wheat. *Plant and Soil,* **74:** 101-109.
12. Kimber, R.W.L. (1973). Phytotoxicities form plant residues. I. The influence of rotted wheat straw on seedling growth. *Aust. J. Agric. Res.*, **18:** 361-374.
13. Martin, V.L., McCoy, E.L. and Dick, W.A. (1990). Allelopathy of crop residues influences corn seed germination and early growth. *Agron. J.,* **82:** 555-560.
14. Melkania, N.P. (1983). Influence of certain selected tree species on ground flora, *Ph.D. Thesis,* Kumaun Unviersity, Nainital. 442 p.
15. Melkania, N.P. (1986). Allelopathy and its significance on production of agroforestry plants association. *Proceeding workshop of Agroforestry for Rural Needs*. Feb.22-26, 1986, New Delhi. ISTS, Solan, pp. 211-224.
16. Molisch, H. (1937). Der Einfluss einer Pflanz auf die andere–Allelopathige. Fischer, Jena, Germany.
17. Muller, C.H. (1966). The role of chemical inhibition (allelopathy) in vegetational composition. *Torrey Bot. Club***, 93:** 332-51.
18. Muller, C.H. (1969). Allelopathy as a factor in eceological process. *Vegetation,* **18**: 348-57.
19. Narwal, S.S., Singh I., Singh, A. and Gupta, K. (1989). Allelopathy effects of pearl millet extract on the seed germination and seedling growth of Indian Colza. *Indian J. Ecol.,* **16**: 84-87.
20. Ong, C.K., Black, C.R., Marshall, F.M. and Corelett, J.E. (1996). Principles of resource capture and utilization of light and water. In: Ong, C.K., Huxely, P. (Eds.), Tree–Crop Interactions. A Physiological approach. CAB International, Wallingford, UK, pp. 73–158.
21. Ovalle, C. and Avendano, J. (1987). Interactions de la strate ligneuse avec la strate herbacée dans les formations d'*Acacia caven (Mol.)* Hook. et Arn. au Chili. *Oecol. Plant*, **9**: 113-134.
22. Patric, A.Z. (1971). Phytotoxic substances associated with the decomposition in soil plant residues. *Soil Sci.*, **III :** 13-18.
23. Patrick, Z.A. and Koch, L.W. (1958). Inhibition of respiration, germination and growth by substances arising during the decomposition of certain plant residues in soil. *Canadian J. Bot.,* **36:** 621-647.

24. Paulino, V.T., Sanchez, M.J.F., Werner. J.C. and Consla, V. (1987). Allelopathic effects of *Eucalyptus* on forage growth, *Rev. Agric*. (Pirachiacaba), **62 :** 17-35.

25. Puri, S. and Bangawa, K. S. (1992). Effect of trees on the yield of irrigated wheat crop in semi-arid regions. *Agroforestry Syst.,* **20:** 229–241.

26. Putnam, A.R. and Tang, C.S. (1986). *The Science of Allelopathy.* Wiley, New York, p. 317.

27. Rafiqul-Hoque, A.T.M., Ahmed, R., Uddin, M.B. and Hossain, M.K. (2003). Allelopathic effect of different concentration of water extracts of *Acacia auriculiformis* leaf on some initial growth parameters of five common agricultural crops. *Pak. J. Agron.* **2:** 92-100.

28. Rice, E.L. (1984). *Allelopathy,* 2nd ed., Academic Press, Orlando, FL, pp. 67–68.

29. Sasikumar, K., Vijayalakshmi, C. and Parthiban, K.T. (2002). Allelopathic effects of eucalyptus on blackgram (*Phaseolus mungo* L.). *Allelopathy J.,* **9:** 205–214.

30. Schroth, G. (1995). The roots characteristics as criteria of species selection and systems design in agroforestry. *Agroforestry Syst.* **29:** 125-143.

31. Stowe, L.G. (1979). Allelopathy and its influence on the distribution of plants in an Illinois old field. *J. Ecology,* **67:** 1065-1085.

HortFlora Research Spectrum, 1(2): 103-109 (2012) ISSN : 2250-2823

COMBINATIONAL IMPACT OF *Debaryomyces hansenii* BIOAGENT AND 1-METHYLECYCLOPROPEN (1-MCP) ON SHELF LIFE AND QUALITY ATTRIBUTES OF KINNOW MANDARIN

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ABSTRACT: Due to rising consumers' concern over chemical/pesticides residue free eatables and international food safety laws, it is felt world wide to find out an alternative approach for postharvest food loss reduction and quality retention. To find out safe postharvest treatment alternatives, Kinnow mandarin fruits were treated individually with 1-MCP (250 nl L^{-1}), *Debaryomyces hansenii* (10^9 cfu ml^{-1} for 2 minutes) and their combination (250 nl L^{-1} + 10^9 cfu ml^{-1}). Treated fruits were stored at 10°C temperature and 85% RH. Their impact on pathological, physical and quality parameters was investigated after 45 days storage. Fruits treated with 1-MCP (250 nl L^{-1}) + *Debaryomyces hansenii* bioagent (10^9 cfu ml^{-1}) resulted in minimum incidence of moulds (green 3.61% and blue 2.05%) over all natural decay (7.25%) and higher sensory score (7.50). Higher fruit firmness and lower PLW was recorded equally good with 1-MCP alone and in combination of *Debaryomyces hansenii* bioagent. Postharvest fruit quality parameters viz TSS, acidity, total sugars and vitamin C content were not affected with the 1-MCP and *Debaryomyces hansenii* either alone or in combination.

Keywords: *Kinnow mandarin, 1-MCP, Debaryomyces hansenii, postharvest decay, quality.*

Kinnow is hybrid mandarin between King and Willow leaf mandarins, developed by Dr. H.B. Frost at California during the year 1935. In India, it was introduced during mid sixties at Regional Fruit Research Station, Abohar (Punjab) for conducting feasibility trials. Where other citrus varieties failed to adopt, Kinnow consistently performed well in semi-arid and sub-mountainous tract of India. Besides India, Kinnow is now a well established citrus fruit in Pakistan and Afghanistan. Basically, characters like precocity and prolificacy in bearing, attractive fruit colour, higher juice content, absence of granulation disorder and heavy returns have attracted the growers to intensify its cultivation in India (Bindra, 6). Several factors have been reported to be associated with postharvest losses of Kinnow mandarin. Postharvest losses caused by fungal diseases and physiological activities (respiration, ethylene liberation and enzyme) are the major factors limiting the shelf life of the Kinnow (Singh and Mandal, 23).

Presently, the control of the postharvest losses relies mainly on use of the synthetic chemicals. Practising non-chemical control methods to reduce postharvest losses is most important and becoming popular world over. Consumers are demanding minimal pesticide load on the fresh produce and many spoilage causing pathogens are developing resistance to several synthetic chemicals (Conway *et al.*, 7). Most of the fungicides have been phased out and rest are used with restriction due to the health concerns. Therefore, it is imperative to find out the safer alternative to minimise environmental degradation and ensure consumer safety. Biocontrol strategy has made much progress during the last decade. At present, several biocontrol treatments have been approved for commercial applications, and now research is focused on improving the bioefficacy of the antagonist. One of the approaches has been the selection of combinations of antagonists, which may work more effectively (Barkai-Golan and Phillip, 5). It is a very challenging work, as microorganisms have differential growth habits, requirements for nutrition and cultural conditions.

Received : 22.3.2012 *Accepted : 11.4.2012*

Naturally occurring micro organisms, which are found to be adhered on the fruits and vegetables surface have been shown potential to protect the fresh produce against postharvest disease causing pathogens. During last decade several products viz Serenade (*Bacillus subtilis* based), Messenger (*Erwinia amylovora* based), Biosave (*Pseudomonas syringae* strain 10 LP), Aspire (*Candida oleophila* strain 1-18), AQ-10 bio-fungicide (*Ampelomyces quisqualis*) have been isolated and registered in the United States and Germany (El-Neshawy *et al.,* 9; Fravel, 10, Plaza *et al.,* 19, Zhao *et al.,* 31,). Use of some safe bioactive compounds have been proved beneficial in bringing down the physiological activities of fruits during transportation, storage and minimizing the over all qualitative and quantitative losses (Porat *et al.*, 20). 1-methylecyclopropen (1-MCP) is a synthetic cyclic olefin that inhibit ethylene by blocking access to the ethylene biding receptor (Sisler *et al.,* 24). Eduardo and Kader (8) investigated that 1-MCP bound at the ethylene receptor in many fruits is still capable of inhibiting cell wall degrading enzymes such as PG secreted by pathogens and thus prevent pathogenesis. The yeast, *Debaryomyces hansenii* has exhibited a wide spectrum of biological activity against many pathogens (Wilson and Chaulutz, 25); it reduces the incidence of the green mould development by competing for space and nutrients at any injury site on the rind of the citrus fruit and thus inhibiting mould development. The bioefficacy of the *Debaryomyces hansenii* has been reported to be enhanced by several workers when it was applied in combination with calcium salts, sodium salts, salicylic acid and waxes (Yu *et al.,* 30, Singh and Mandal, 23). However, there is no information concerning the combinational effect of bio agent and 1-MCP on postharvest diseases and quality attributes of the Kinnow mandarin fruits.

The objectives of this study were to determine postharvest loss reduction and quality retention of the Kinnow mandarin fruits by combined application of the *Debaryomyces hansenii* and 1-MCP.

MATERIALS AND METHODS

Kinnow mandarin fruits were manually harvested at commercial maturity stage from 10-year old orchard in Abohar (Punjab) during January 2008. After preliminary selection, fruit that had blemishes or otherwise appeared over mature were discarded. Selected fruit were washed with tap water, air dried prior to treatment with 1-MCP and *Debaryomyces hansenii*. 1-MCP (3.3% powder) was obtained from Rohm and Hass, Italy.

Freshly harvested fruits were treated for 2 minutes each with distilled water, 1-MCP (500 nl L^{-1}), 1-MCP (500 nl L^{-1}) + *Debaryomyces hansenii* slurry (10^9 cfu ml^{-1}) and *Debaryomyces hansenii* slurry (10^9 cfu ml^{-1}). Ten fruits were taken in each treatment and replicated thrice. Treated fruits were packed into CFB boxes and placed into cold storage (10°C; 85% RH) just after drying off surface water.

Weight of individual lot containing 10 fruits each was recorded at day 0 (A) and at the scheduled sampling date (B). Physiological loss in weight was calculated as (A-B)/A x100 and expressed as percentage loss in original fresh weight.

Respiration rate was measured based on 'closed system' by using auto gas analyzer (Model: Checkmate 9900 O_2/CO_2, PBI Dansensor, Denmark) and expressed as ml CO_2 kg^{-1} h^{-1}. Known weight of whole Kinnow mandarin fruits were trapped in two-liter airtight container having twist-top lid fitted with a silicon rubber septum at the centre of the lid. The containers were kept at 25°C for 2-3 hours for accumulation of respiratory gases in the head space. After specified time, the head space gas was sucked to the sensor of analyzer through the hypodermic hollow needle and the displayed value of evolution rate of CO_2 concentration (%) was recorded. Rate of respiration was calculated on the basis of rate of evolution of CO_2 from the sample per unit weight per unit time (Asrey *et al.,* 3).

Total sugars were determined by the method described by AOAC (2) by taking a known quantity

of homogenized pulp, using lead acetate to remove excess of lead free aliquot were examined by titrating against boiling Fehling's solution, which had previously been standardized using methylene blue indicator. Total sugars were determined after complete inversion of non-reducing sugars by acid hydrolysis and aliquot of this lead free solution were analyzed by similar method as described earlier. The data were expressed in percentage.

Total soluble solids contents were determined by measuring refractive index of the juice samples with hand refractometer and the results were expressed in percentages (Larrigaudiere *et al.,* 15).

By using 2,6-dichloroindophenol indicator titrimetric method, the ascorbic acid content of the fruit juice was determined. Results were expressed as milligrams of ascorbic acid per 100 g sample (Ozden and Bayindirili, 18).

Pressed fruit juice acidity was measured by titration with 0.1N NaOH to pH 8.1, 4g of juice diluted with 20 ml of double distilled water. Titratable acidity was calculated and expressed as per cent malic acid (Wright and Kader, 29).

The anti-oxidant capacity of the fruit pulp was determined by the FRAP (ferric reducing ability of plasma) method. Fruit hardness was determined using a texture analyzer (model: TA+Di, Stable Micro-systems, UK) using compression. The sample was compressed using a cutting and hardness was defined as maximum force (kgf) during compression.

Obtained data were subjected to analysis of the variance (ANOVA) using SAS package. Statistical significance was assessed at P=0.05 and least significant difference was used for pair-wise comparison of the means.

RESULTS AND DISCUSSION

1. Effect on disease control, physiological and physical parameters

Application of 1-MCP and *Debaryomyces hansenii* individually as well as in combination, significantly affected the disease incidence, physiological and physical parameters of stored Kinnow mandarin fruits (Table1). Minimum incidence percentage of both the moulds (3.61 green and 2.05 blue) was recorded in *Debaryomyces hansenii* (10^9 cfu ml^{-1}) + 1-MCP (750 nl L^{-1}) treated fruit after 45 days of cold storage (10°C temperature and 85% RH). Significnat variation in incidence (P=0.05) was found within the treatments. The incidence suppression efficacy of *Debaryomyces hansenii* and 1-MCP was found higher against blue mould rot over green mould rot. The decay and physiological loss in weight was also found lower with MCP + *Debaryomyces hansenii* treated fruits (4.45 and 7.25%, respectively) (Fig. 1 and 2).

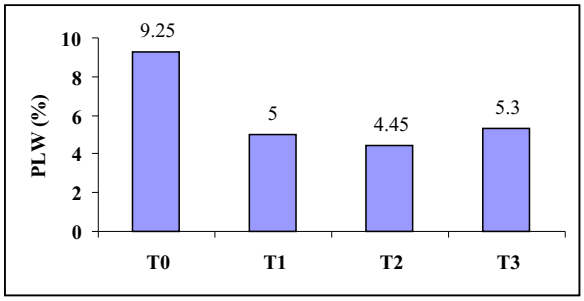

Fig. 1. Impact of 1-MCP and *Debaryomyces hansenii* on PLW of Kinnow madarin after 45 days storage at 10°C and 85% RH. Each value is the mean of three replications.

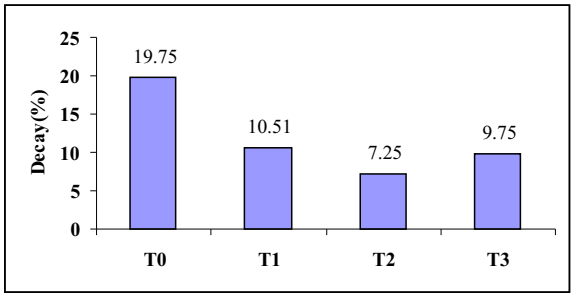

Fig. 2. Impact of 1-MCP and *Debaryomyces hansenii* on decay of Kinnow madarin after 45 days storage at 10°C and 85% RH. Each value is the mean of three replications.

where,

T_0-Control

T_1-1-MCP (250 nl L^{-1})

T_2-1-MCP (250 nl L^{-1} + *Debaryomyces hansenii* 10^9 cfu ml^{-1})

T_3-*Debaryomyces hansenii* (10^9 cfu ml^{-1})

The fruit firmness was decreased in all the treatments in due course of time during storage. Firmness of fruit was not significantly changed due to sole treatment of *Debaryomyces hansenii* while it was found affected with 1-MCP and in combination (1-MCP + *Debaryomyces hansenii*). Maximum firmness (6.67 Kgf) was recorded in 1-MCP treated fruits.

Respiration rate of stored fruits was neither significantly changed due to sole application of *Debaryomyces hansenii* nor its combined application with 1-MCP. Interestingly, fruit treatment with 1-MCP alone, reduced the respiration rate (1.17 $\mu L\ k^{-1}\ h^{-1}$) of stored Kinnow mandarin fruit. In respect to organoleptic rating of the Kinnow mandarin fruits 45 days after storage, all the treatment significantly affected the fruit acceptability score. 1-MCP + *Debaryomyces hansenii* application followed by 1-MCP alone (250 nl L^{-1}) retained the higher organoleptic rating of 7.50 and 6.58, respectively.

2. Effect on post harvest fruit quality parameters

Debaryomyces hansenii and 1-MCP neither individually nor in combination had affected the postharvest quality related chemical traits of the treated Kinnow mandarin fruits. The difference in the total soluble solids (TSS), titratable acidity, total sugars, vitamin C and total antioxidant capacity of the fruit juice was found non significant in all the treatments after 45 days storage at 10°C and 85% RH (Table 2).

The fruit treated with *Debaryomyces hansenii* were found least prone to blue mould and green mould rot caused by the *Penicillium digitatum* and *Penicillium italicum.* Furthermore, the blue and green mould controlling efficiency of *Debaryomyces hansenii* was increased when it was used along with 1-MCP (10^9 cfu ml^{-1} + 250 nl L^{-1}). These findings indicate that *Debaryomyces hansenii* has potential to supress the blue and green mould causing pathogens in Kinnow mandarin. 1-MCP has given synergistic strength to bioagent (*Debaryomyces hansenii*) in sharpening its antagonism against blue and green mould caused by Penicillium italicum and *Penicillium digitatum*, respectively. *Debaryomyces hansenii* exerts antagonism through competition with pathogen for space and nutrients (Singh and Mandal, 23). As the 1-MCP has ability to reduce respiration rate, cell wall softening enzyme activities (Eduardo and Kader, 8; Win *et al.,* 28) and fruit firmness retention; its application with Debaryomyces hansenii might have reduced the nutrient availability to the pathogen which intern resulted into less incidence percentage of moulds in stored Kinnow mandarin fruits. These findings are in agreement with the results of other work carried out on these aspects (Singh, 22; Wilson *et al.,* 26). They found that the competition for nutrients and growing space is the main mode of action of antagonistic yeast to control postharvest storage diseases of fruits. The bio-control of antagonistic yeast encompasses several modes of action viz. mycoparasitism, induced resistance, production of lyetic enzymes (chitinase and glucanase), limiting spore germination and elongation of germ tube (Wilson *et al.,* 27; Zheng *et al.,* 32). 1-MCP is a synthetic cyclic olefin that inhibits ethylene by blocking access to the ethylene binding receptor, lowers action of maturation associated genes (PC-PG1 and PC-PG2) and enzymes (Sisler and Serek, 24; Khan and Singh, 14, and Martinez *et al.,* 17). The combined application of 1-MCP and *Debaryomyces hansenii* have been succeeded in keeping over all fruit decay percentage at its minimum level (7.25%), while their impact on fruit firmness and respiration rate was at par with 1-MCP or bioagent treated fruits, respectively. Minimum fruit decay loss by the combined application of 1-MCP and *Debaryomyces hansenii* may be attributed due to the higher fruit firmness (1-MCP treatment retained higher fruit firmness), which has likely prevented the pathogen invasion in stored fruits. Aguayo *et al.* (1) also recorded less decay loss in 1-MCP + $CaCl_2$ treated strawberry fruit kept at room temperature and cold storage.

Respiration rate, PLW and fruit firmness of the stored fruits remained unaffected with the bioagent

Table 1: Impact of 1-MCP and *Debaryomyces hansenii* on quality attributes and mould rot control of Kinnow after 45 days storage at 10°C temperature and 85% R.H.

Treatment	Firmness (Kgf)	Respiration (ml CO_2 k^{-1} h^{-1})	Green mould incidence (%)	Blue mould incidence (%)	Sensory score
Control	6.47b	1.23ab	8.32a	6.23a	5.58c
1-MCP (250 nl L^{-1})	6.67ab	1.17b	5.66b	3.78b	6.58b
1-MCP (250 nl L^{-1} + *Debaryomyces hansenii* 10^9 cfu ml^{-1})	6.52a	1.28b	3.61c	2.05c	7.50a
Debaryomyces hansenii (10^9 cfu ml^{-1})	6.46b	1.33a	4.20c	3.59b	5.83c
Initial value	7.01	1.16	0.00	0.00	7.60
CD (P=0.05)	0.17	0.12	1.30	0.96	0.70

Means with the same letter, do not differ significantly as per Duncan Multiple Range Test

Table 2: Impact of 1-MCP and *Debaryomyces hansenii* on quality attributes of Kinnow mandarin after 45 days storage at 10°C temperature and 85% R.H.

Treatment	TSS (%)	Acidity (%)	Sugars (%)	Vitamin C (mg 100 ml^{-1} juice)	Antioxidant (mg Fe^{++} 100 ml^{-1} juice)
Control	11.42a	1.07a	10.16a	19.61a	123.51b
1-MCP (250 nl L^{-1})	10.75a	1.09a	10.32a	20.21a	127.07a
1-MCP (250 nl L^{-1} + *Debaryomyces hansenii* 10^9 cfu ml^{-1})	11.17a	1.07a	10.35a	20.23a	126.82a
Debaryomyces hansenii (10^9 cfu ml^{-1})	11.26a	1.09a	10.39a	20.23a	124.55b
Initial value	11.17	1.05	10.25	21.26	128.37
C.D. (P=0.05)	NS	NS	NS	NS	2.14

Means with the same letter, do not differ significantly as per Duncan Multiple Range Test.

(*Debaryomyces hansenii*) application. As all above parameters are interdependent and any change in an individual affect the value of other one. These results are in expected lines, because the *Debaryomyces hansenii* treatment was given to the intact fruits (no wounding and artificial inoculation). So, practically there will be no difference in the physiology of bioagent treated healthy fruits and control fruits. When there is interaction of pathogen, fruits and bioagent cells, the physiological activities will increase according the severity of pathogenicity level. These findings got support of Hiwasa *et al.* (12); Manganaris *et al.* (16) and Singh and Mandal *et al*. (23).

The variation in postharvest quality parameters (TSS, acidity, sugar, vitamin C) of stored Kinnow mandarin fruits were insignificant in all the treatments, whereas antioxidant capacity of the stored Kinnow fruit shown significant difference under 1-MCP and 1-MCP + *Debaryomyces hansenii* treated fruit juice. The results are in conformity of earlier workers (Bai *et al.,* 4; Gutierrez *et al.,* 11; and Itai *et al.* 13, and Singh, 21).

In conclusion, our findings show that the 1-MCP and *Debaryomyces hansenii* are compatible with each other. For controlling postharvest deterioration and diseases, 1-MCP and

Debaryomyces hansenii are utilized individually or 1-MCP with any fungicide. For evolving further more eco-friendly green postharvest treatment technology, it is required to find out alternatives for 1-MCP with the use of bio-based formulations. Their respective antifungal and antisenescense potential may be gainfully utilized in postharvest disease control and shelf life extension of Kinnow fruits.

REFERENCES

1. Aguayo, E., Jansasithorn, R. and Kader, A.A. (2007). Combined effects of 1-methylcyclo-propene, calcium chloride dip, and/or atmospheric modification on quality changes in fresh-cut strawberries. *Postharvest Biol. and Tech.,* **40 :** 269–278.
2. AOAC (1995). *Official Methods of Analysis*, 16th ed. 45.1.14. AOAC, Arlington, Virginia.
3. Asrey, Ram, Jain, R.K. and Kumar, A. (2008). Maturity, transportation and storage study in strawberry fruit. *J. Food Sci. Tech.,* **45:** 540-542.
4. Bai, J., Baldwin, E.A., Goodner, K.L., Mattheis, J.P. and Brecht, J.K. (2005). Response of four apple cultivars to 1-methylcyclopropene treatment and controlled atmosphere storage. *Hort. Sci*., **40:** 1534-1538.
5. Barkai-Golan, R. and Phillip, D.J., (1991). Postharvest fruit treatment of fresh fruits and vegetables for decay control. *Plant Diseases,* **75:** 1085-1089
6. Bindra, A.S., (1990). In:*Citriculture in north western India,* K.S. Gill,K.S., Kanwar,J.S., Singh,R.(eds),Prospects and problems of citrus growing in Punjab with special reference to 'Kinnow'pp- 83-99.
7. Conway, W.S., Leverentz, B., Janisiewicz, W.J., Blodgett, A.B., Saftner, R.A. and Camp, M.J., (2004). Integrating heat treatment, biocontrol and sodium bicarbonate to reduce postharvest decay of apple caused by *Colletotrichum acutatum* and *Penicillium expansum. Postharvest Biol. and Tech.* **32:** 11-20.
8. Eduardo,V.B. and Kader, A.A. (2007). Effect of 1- methylecyclopropen on softening of fresh cut kiwifruit, mango and persimmon slices. *Postharvest Biol. and Tech.,* **43:** 238-244.
9. El-Neshawy, S.M. and El-Sheikh, M.M., (1998). Control of green mould on oranges by *Candida oleophila* and calcium treatments. *Annals Agric. Sci. Cairo* (Special Issue), **3:** 881-890.
10. Fravel, D.R. (2005). Commercialization and implementation of biocontrol. *Annual Rev. Plant Biol.,* **43:** 337-359.
11. Gutierrez, S.M., Trinchero, D.G., Cerri, M.A., Vilella, F. and Sozzi, O.G. (2008). Different responses of goldenberry fruit treated at four maturity stages with the ethylene antagonist 1-methylcyclopropene. *Postharvest Biol. and Tech.* **48:** 199-205.
12. Hiwasa, K., Kinugasa, Y., Amano, A., Hashimoto, A., Nakano, R., Inaba, A. and Kubo, Y. (2003). Ethylene is required for both the initiation and progression of softening in pear (*Pyrus communis* L.) fruit. *J. Experi. Bot*., **54:** 771-779.
13. Itai, A. and Tanahashi, T. (2008). Inhibition of sucrose loss during cold storage in Japanese pear (*Pyrus pyrifolia* Nakai) by 1-MCP. *Postharvest Biol. and Tech*., **48:** 355-363.
14. Khan, A.S. and Singh, Z. (2007). 1-MCP regulates ethylene biosynthesis and fruit softening during ripening of 'Tegan Blue' plum. *Postharvest Biol. and Tech.,* **43:** 298-306.
15. Larrigaudiere, C., Pons, J., Torres, R. and Usall, J. (2002). Storage performance of Clementines treated with heat water, sodium carbonate and sodium bicarbonate dips. *J. Hort. Sci. Biotech.,* **77:** 314-319.
16. Manganaris, G.A., Crisosto, C.H., Bremer, V. and Holcroft, D. (2008). Novel 1-methylcyclo-propene immersion formulation extends shelf life of advanced maturity 'Joanna Red' plums (*Prunus salicina* Lindell). *Postharvest Biol. and Tech.* **47:** 429-433.
17. Martinez, X.C., Alonso, J.M., Sanchez, B. and Granel, A. (2002). Ethylene perception and response in citrus fruit. In: *Kanellis,* A.K.,

Grierson, D. (Eds.), Kluwer Academic Publisher, The Netherlands, 137-142.

18. Ozden, C. and Bayindirli, L. (2002). Effect of combinational use of controlled atmosphere cold storage and edible coating applications on shelf life and quality attributes of green peppers. *European Food Res. Tech.*, **21:** 320-326.
19. Plaza, P., Torres, R., Teixido, N., Usall, J., Abadias, M. and Vinas, I. (2001). Control of green mould by the combination of Pantoea agglomerans (CPA-2) and sodium bicarbonate on oranges. *Bulletin-OILB/SROP,* **24**(3): 167-170.
20. Porat, R., Cohen, B.W.L., Avinoam, D., Raphael, G. and Samir, D. (1999). Effects of ethylene and 1-methylcyclopropene on the postharvest qualities of 'Shamouti' oranges. *Postharvest Biol. and Tech.* **15:** 155-163.
21. Singh, D. (2002). Bioefficacy of *Debarymyces hansenii* on the incidence and growth of *Penicillium italicum* on Kinnow fruit in combination with oil and wax emulsions. *Annals Plant Protec. Sci*., **10:** 272-276.
22. Singh, D. (2004). Effect of *Debaryomyces* hansenii and calcium salt on fruit rot of peach (*Rhizopus macrosporus*). *Annals Plant Protec. Sci.,* **12:** 310-313.
23. Singh, D. and Mandal, G. (2006). Improved control of *Rhizopus stolonifer* – induced storage rot of peach with hot water and antagonistic yeast, *Debaryomyces hansenii*. *Indian Phytopath.,* **59:** 168-173.
24. Sisler, E.C. and Serek, M. (1997). Inhibitors of ethylene responses implants at the receptor level: recent developments. *Physiol. Plant,* **100:** 577-582.
25. Wilson, C.L. and Chaultz, E. (1989). Postharvest biocontrol of *Penicillium* rots of citrus with antagonistic yeasts and bacteria. *Scientia Hort.*, **40:** 105-112.
26. Wilson, C.L., Wisniewski, M., El-Ghaouth, A., Droby, S. and Chalutz, E. (1996). Commercialization of antagonistic yeasts for the biological control of post harvest diseases of fruits and vegetables. *J. Microbiol. Biotech*., **46:** 237-242.
27. Wilson, C.L., Wisniewski, M.E., Biles, C.L., McLaughlin, R., Chalutz, E. and Droby, E. (1991). Biological control of postharvest disease of fruits and vegetables: alternatives to synthetic fungicides. *Crop Protec.,* **10:** 172-177.
28. Win, T.O., Srilaong, V., Julian, H., Khin, L.K. and Sirichai, K. (2006). Effects of different concentrations of 1-MCP on the yellowing of West Indian lime (*Citrus aurantifolia,* Swingle) fruit. *Postharvest Biol. and Tech.* **42:** 23-30.
29. Wright, K.P. and Kader, A.A. (1997). Effect of controlled-atmosphere storage on the quality and carotenoid content of sliced persimmons and peaches. *Postharvest Biol. and Tech*. **10:** 89-97.
30. Yu, T. and Zheng, X.D. (2007). An integrated strategy to control postharvest blue and grey mould rots of apple fruit by combining biocontrol yeast with gibberellic acid. *International J. Food Sci. Tech.* **42:** 977-984.
31. Zhao, Y., Shao, X.F., Tu, K. and Chen, J.K. (2007). Inhibitory effect of *Bacillus subtilis* B10 on the diseases of postharvest strawberry. *J. Fruit Sci.,* **24:** 339-343.
32. Zheng, X.D., Zhang, H.Y. and Xi, Y.F. (2004). Effects of *Cryptococcus laurentii* (Kufferath) Skinner on biocontrol of postharvest decay of arbutus berries. *Bot. Bull. Acad. Sinicia,* **45:** 55-60.

HortFlora Research Spectrum, 1(2): 110-116 (2012) ISSN : 2250-2823

STUDIES ON GENETIC VARIABILITY AND CHARACTERS ASSOCIATION OF FRUIT QUALITY PARAMETERS IN TOMATO

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ABSTRACT : The genetic variability and characters association of different fruit quality parameters were studied in 15 tomato genotypes grown in a two year field experiments. High and moderate to high GCV and PCV were recorded for number of locules / fruit, fruit weight, total acid (%), number of fruits/plant, vitamin C (mg /100g), fruit yield /plant, fruit length and pericarp thickness. High and moderate to high heritability coupled with high and moderate to high genetic gain in number of locules/fruit, fruit weight, fruit length, number of fruits/plant, pericarp thickness, vitamin C (mg/100g) and total acid (%) indicated the predominance of additive gene action, and therefore, these are more reliable for effective selection. Correlation coefficient revealed that fruit yield per plant was positively and significantly correlated with pericarp thickness, fruit length, fruit weight and number of fruits/plant indicating relative importance of these characters for yield improvement. Significantly positive and negative associations among different fruit quality parameters were also observed in the present study. The path coefficient analysis revealed that number of locules /fruit, TSS, fruit length, number of fruits/plant, fruit weight, vitamin C content and pericarp thickness had positive direct effect on fruit yield, while fruit width and total acid content had strong negative effects on the fruit yield.

Keywords: *Tomato, path analysis, correlation, GCV, PCV, heritability.*

Among different vegetable crops, tomato is one of the most popular and widely grown in the world. India's share to the world's production is only 14%, while it is about 26% in case of China. In India, the productivity of tomato is very low (15.60 t/ha) compared to the average productivity (25.09 t/ha) of the world. To improve the productivity of tomato, the primary consideration should be to bring about genetic improvement of the crop and development of superior varieties by selection among and within the population through the use of scientific breeding programme based upon the available genetic variability. It is, therefore, essential to assess the quantum of genetic variability, nature of character association with respect to different characters, which would help plant breeders in planning a successful breeding programme. Besides some yield contribution traits, some fruit quality parameters also affect the yield. The present investigation was, therefore, undertaken with a view to assess the nature of variability, heritability and genetic advance, and to determine the nature of association of different fruit quality parameters on fruit itself and among themselves through correlation and path analysis.

MATERIALS AND METHODS

The experimental materials for present studies consisting 15 diverse genotypes of tomato, viz. Sel 12, Sioux, Roma, Pusa Ruby, Solan Gola, Solan Vajer, S15998, EC 110964, EC 12217, Utkal Urbasi, Utkal Pallavi, Utkal Kumari, Utkal Deepti, Elegant and S22 were sown at Horticulture Farm of Palli Siksha Bhavan (Institute of Agriculture), Visva-Bharati, Birbhum, West Bengal (23°29' N, 87° 42'E and 58.9 m asl) during two 'rabi' seasons. These genotypes were sown in seed-bed during the month of November, and the seedlings were transplanted in the main field 25 days after sowing. The experiments were arranged in a randomized complete block design with three replications. Standard agronomic practices were followed to raise the crop.

Received : 24.3.2012 *Accepted : 12.4.2012*

Samples were collected during peak period at harvest at full ripe stage of maturity (at both the growing seasons). A composite sample of 10-15 fruits was taken from selected plants of all the three replications. Evaluation was done on the same day for various quality parameters, viz. pericarp thickness, fruit length, fruit width, fruit weight, number of locules per fruit and biochemical traits viz. total soluble solids (°Brix), total acid content (%), vitamin C content (mg/100g). TSS content of fruit juice was estimated with the help of a hand refractometer (ERMA) calibrated at 20°C. The data thus obtained were corrected for temperature correction from standard correction table and represented in °Brix (A.O.A.C., 1). Total acidity was determined by titrating the diluted fruit juice against 0.1 (N) NaOH solution using phenolphthalein as an indicator (A.O.A.C., 1). The data were represented in terms of percentage of citric acid. The 2, 6-dichlorophenal indophenols dye titration method was used to estimate the ascorbic acid content of the fruit juice (Ranganna, 27).

Data collected during the two growing seasons on these traits were pooled, and analysis of variance was done as suggested by Panse and Sukhatme (24). Variability was estimated following Burton and De Vane (6). Heritability and genetic advance were calculated according to Hanson *et al*. (12) and Johnson *et al.* (14), respectively. Correlations were undertaken as per the procedure suggested by Johnson *et al.* (14) and Al Jibouri *et al.* (2) along with path coefficient analysis by Dewey and Lu (8).

RESULTS AND DISACUSSION

The analysis of variance revealed that all the characters exhibited highly significant difference among the genotypes, which was evident from the higher range for all the characters (Table 1). The estimates of PCV and GCV values for all the characters under study were almost same indicating little influence of environment and consequently greater role of genetic factors influencing the expression of these characters.

The estimates of GCV and PCV respectively were high (>30%) for locules /fruit (42.13 and 43.19) followed by fruit weight (34.84 and 35.38); moderate (20-30%) for total acid per cent (28.82 and 29.9), fruits/plant (27.39 and 29.91), vitamin C content (mg/100g) (27.32 and 27.50), fruit yield/plant (26.71 and 27.13), fruit length (24.17 and 24.86) and pericarp thickness (20.06 and 21.06); and low (<20%) for fruit width (13.40 and 14.01) and TSS (°Brix) (7.16 and 7.82). Similar results of high, and moderate to high GCV and PCV for these characters were also observed earlier by Mohanty (19,20), Phookan *et al.* (25), Sahu and Mishra (29), Singh *et al.* (32), Das *et al.* (7), Brar *et al.* (5) and Joshi *et al.* (15). Low estimates of GCV and PCV for TSS were earlier reported by Kumar and Tewari (17).

The genotypic coefficient of variation does not offer full scope to estimate the variation that is heritable, and therefore, estimation of heritability becomes necessary. The magnitude of heritability ranged from 81.90% (pericarp thickness) to 98.70% (vitamin C content). The results observed in present investigation were in agreement with the findings of Kumar and Tewari (17), Singh (34) for vitamin C content; Das *et al.* (7), Singh *et al.* (31) and Singh *et al.* (32) for locules per fruit, fruit weight; Reddy and Reddy (28), Pujari *et al.* (26), Sahu and Mishra (29), Padmini and Vadivel (23), Phookan *et al.* (25), Bharti *et al.* (3) and Mohanty *et al.* (19,20) for fruit yield /plant, number of fruits/plant, fruit weight; Das *et al.* (7) for pericarp thickness, length and width of the fruit; Joshi *et al*. (15), and Kumar *et al.* (16) for TSS. However, moderate to low estimates of heritability for locules/fruit have been reported by Joshi *et al.* (15). High heritability suggested the major role of genetic constitution in the expression of characters, and such traits are considered to be dependable from breeding point of view. However, the estimates of heritability alone are not sufficient for predicting the effect of selection. According to Johnson *et al.* (14), heritability used in conjunction with genetic advance provides better information for selecting the best individuals than the

heritability alone. The value of genetic advance as per cent of mean (genetic gain) ranged from 13.54 (TSS) to 84.86 (locules/fruit). High and moderate to high estimates of heritability accompanied with high and moderate to high genetic gain for locules/fruit, fruit weight, fruit length, fruits/plant, pericarp thickness, total acid (%), fruit yield/plant and vitamin C content indicated the predominance of additive gene action for the expression of these characters. Hence, selection for the above characters would be effective for improvement of yield in this population. A perusal of the Table 1, wherein the results of PCV, GCV, heritability and genetic advance have been furnished, revealed that selection for fruits/plant, fruit weight, fruit length would be effective for improvement of fruit yield, whereas, selection for pericarp thickness, total acid, vitamin C content, locules/fruit as well as the fruit weight would be effective for the quality improvement of the fruit.

An estimate of genotypic and phenotypic (genotypic and phenotypic) correlation coefficients

Table 1: Estimates of range, mean, genotypic and phenotypic coefficient of variability, heritability and genetic advance for different traits in tomato.

Characters	Grand mean	Range	Coefficient of variance (%)	Heritability	Genetic advance	Genetic advance as per cent of mean	
			GCV	PCV			
1. Fruits per plant	23.30	15.32-37.00	27.39	29.91	83.9	12.04	51.67
2. Fruit length	4.07	2.88-6.63	24.17	24.86	94.5	1.97	48.40
3. Fruit width	4.44	3.40-5.50	13.40	14.01	91.5	1.17	26.35
4. Fruit weight (g)	43.62	23.50-88.67	34.84	35.38	97.0	30.84	70.70
5. Locules per fruit	3.18	2.00-6.00	42.13	43.19	95.10	2.69	84.86
6. Pericarp thickness	0.51	0.37-0.70	19.06	21.06	81.9	0.18	35.29
7. T.S.S.	6.57	5.58-7.53	7.16	7.82	83.8	0.89	13.54
8. Vitamin C (mg/100g)	46.06	27.47-77.92	27.32	27.50	98.7	25.75	55.91
9. Total acid (%)	0.48	0.30-0.73	28.82	29.90	92.9	0.28	58.33
10. Fruit yield per plant	825.30	437.10-1285.00	26.71	27.13	97.0	447.23	54.19

correlation coefficient among different pairs of characters of tomato is presented in Table 2. An overview of the table revealed that, in general, the genotypic and phenotypic correlations showed similar trend but genotypic correlation were at higher magnitude than phenotypic correlation in most of the cases. Very close values of genotypic and phenotypic correlation were also observed between some characters combinations that might be due to reduction in error (environmental) variance to minor proportions as reported by Dewey and Lu (8). Highly significant and positive with fruit yield were found for pericarp thickness (0.618 and 0.556) followed by fruit length (0.564 and 0.533), fruit weight (0.455 and 0.436) and fruits/plant (0.252 and 0.245) indicating importance of these characters for yield improvement. In former studies with tomato, fruit length, fruit weight (Das *et al.* 7; Yadav and Singh,36; Padma *et al.* 22; Joshi *et al.* 15); pericarp thickness (Bhushana *et al.* 4; Kumar *et al.* 18; Joshi *et al.* 15) and fruits/plant (Dhankar *et al.* 9; Harer *et al.* 13; Singh *et al.* 33) exhibited strong positive correlations with fruit yield. In the present study,

total acid was also highly and positively correlated with fruit yield/plant. Significant positive genotypic and phenotypic correlations were also observed for fruit length with fruit weight (0.263 and 0.253), pericarp thickness (0.631 and 0.532); fruit width with locules/fruit (0.518 and 0.461) and Vitamin C content (0.392 and 0.375); fruit weight with pericarp thickness (0.424 and 0.369); locules per fruit with TSS (0.476 and 0.435), vitamin C content (0.216 and 0.213) and total acid content (0.235 and 0.217); and TSS with vitamin C content (0.339 and 0.310).

Although reports on the nature of character association in these traits are scanty, Das *et al.* (7) reported positive correlation of fruit weight and number of locules per fruit with fruit width, while positive association between total acidity and number of locules /fruit were reported by Kumar *et al.* (16).

Fruit yield per plant was negative and significantly correlated with locules /fruit, TSS and vitamin C content at both genotypic and phenotypic levels (Table 2). The results are in agreement with Padma *et al.* (22) and Mohanty (20). Significant negative correlation at both the levels were observed for fruits/plant with fruit length, fruit width, fruit weight, locules/fruit and vitamin C content which are at par with the findings of Mohanty (19,20), Padma *et al.* (22), Joshi et al. (15) and Singh *et al.* (33). In the present study, negative and significant correlation at both the levels were also observed for fruit length with locules/fruit, TSS and vitamin C content; fruit width with TSS; fruit weight with locules/fruit, TSS and Vitamin C content; locules/fruit with pericarp thickness; TSS with pericarp thickness and total acid content; and vitamin C content with total acid content. Padma *et al.* (22) also reported negative association between fruit weight and TSS, while negative correlation between locules/fruit with pericarp thickness, and fruit weight with vitamin C content were reported by Kumar and Tewari (17), and Joshi *et al*. (15), respectively. However, reports on the nature of the other character association are scanty and so has not been cited here.

Although correlation studies are helpful in determining the components of yield but it does not provide a clear picture of nature and extent of contributions made by number of independent traits. Path coefficient analysis, however, provides a realistic basis for allocation of appropriate weightage to various attributes while designing a pragmatic breeding programme for improvement of yield. The path coefficient analysis revealed that number of locules/fruit, TSS, fruit length, fruits/plant, fruit weight, vitamin C content and pericarp thickness had positive direct effects, in that order, on fruit yield while fruit width and total acid content had strong negative direct effects. The results are in conformity with Moya *et al*. (21) , Domini and Moya (10), Vikram and Kohli (35), Yadav and Singh (36), Sharma and Verma (30), Bhushana *et al.* (4) Dhankar *et al.* (9), Mohanty (19,20), Padma *et al.* (22), Harer *et al.* (13), Kumar *et al.* (16), Joshi *et al.* (15) and Singh *et al.* (33). Regarding indirect effects, it was observed that fruit width exhibited positive indirect effects towards fruit yield mainly via number of locules/fruit, TSS and vitamin C content; total acid content via TSS and number of locules/fruit. The main effects of number of locules /fruit and vitamin C content were significantly negative and resulted mainly from the negative indirect effects *via* TSS, fruit width, fruit length and fruit weight, whereas, the main effects of vitamin C content was significantly negative as it resulted from the negative indirect effect via fruit length, fruit weight, TSS and fruit width. The main effects of fruit weight and pericarp thickness were significantly positive and resulted mainly from the direct effect of the characters as well as from the positive indirect effects via fruit length and TSS.

Similarly for the character like fruit length, the positive and significant correlation coefficient was due to direct effect of the character as well as indirect effect via TSS and fruit weight indicating selection of these traits would be rewarding.

Total acid content had negative direct effect,

Table 2: Genotypic and phenotypic correlation coefficients of different fruit quality traits in tomato.

Characters		Fruit length	Fruit width	Fruit weight	Locules per fruit	Pericarp thickness	TSS (°Brix)	Vitamin C (mg/100g)	Total acid (%)	Fruit yield per plant
Fruits per plant	G	-0.258**	-0.704**	-0.343**	-0.379**	0.077	0.084	-0.144	0.011	0.152
	P	-0.217*	-0.596**	-0.316**	-0.350**	0.082	0.097	-0.131	0.001	0.145
Fruit length	G		-0.081	0.263**	-0.251	0.631**	-0.212*	-0.463**	-0.013	0.564**
	P		-0.068	0.253**	-0.239**	0.532**	-0.186	-0.44*	-0.009	0.533**
Fruit width	G			0.107	0.518**	-0.092	-0.329**	0.392**	0.003	-0.093
	P			-0.093	0.461**	-0.096	-0.263**	0.375**	0.016	-0.078
Fruit weight	G				-0.229*	0.424**	-0.420**	-0.331**	-0.367**	0.455**
	P				-0.229*	0.369**	-0.393**	-0.329**	0.346**	0.436**
Locules per fruit	G					-0.490**	0.476**	0.216**	0.235*	-0.353**
	P					-0.421**	0.435**	0.213**	0.217*	0.342**
Pericarp thickness	G						-0.355**	-0.316**	0.006	0.618**
	P						-0.325**	-0.275**	0.046	0.556**
TSS (°Brix)	G							0.339**	-0.339**	-0.351**
	P							0.310**	-0.297**	-0.316**
Vitamin C (mg/100g)	G								-0.303**	-0.47**
	P								-0.287**	-0.460**
Total acid (%)	G									0.251**
	P									0.234*

*Significant at 5% level **Significant at 1% level.

Table 3: Genotypic path coefficient of different fruit characters on fruit yield in tomato.

Characters	Fruits/ plant	Fruit length	Fruit width	Fruit weight	Locules/ fruit	Pericarp thickness	TSS (oBrix)	VitaminC (mg/100g)	Total acid	Fruit yield /plant
Fruits per plant	**0.605**	-0.159	0.327	-0.202	-0.324	0.012	-0.062	-0.043	-0.004	0.152
Fruit length	-0.156	**0.615**	0.038	0.154	-0.214	0.102	0.157	-0.137	0.004	0.564**
Fruit width	-0.426	-0.05	**-0.465**	0.063	0.442	-0.015	0.243	0.116	-0.001	-0.093
Fruit weight	-0.208	0.162	-0.05	**0.588**	-0.196	0.068	0.311	-0.098	-0.123	0.455**
Locules per fruit	-0.229	-0.155	-0.241	-0.135	**0.853**	-0.079	-0.352	0.064	-0.079	-0.353**
Pericarp thickness	0.047	0.388	-0.043	0.249	-0.418	**0.161**	0.263	-0.093	-0.022	0.618**
TSS (°Brix)	0.051	-0.131	0.153	-0.247	0.406	-0.057	**0.74**	0.1	0.113	-0.35 **
VitaminC (mg/100g)	0.087	-0.285	-0.183	-0.194	0.185	-0.051	-0.251	**0.295**	0.101	-0.47 **
Total acid (%)	0.007	-0.008	-0.001	0.216	0.201	0.011	0.25	-0.089	**-0.334**	0.251**

Residual = 0.315 * Significant at 5% level ** Significant at 1% level Diagonal values (Bold) indicate direct effects

but high positive indirect effects through fruit weight, TSS and number of locules /fruit caused positively significant correlation. So, for the characters like fruit width and total acid, the indirect causal factors (mentioned above) are to be considered simultaneously for selection, since indirect effects seem to be the cause of correlation.

From the foregoing results it can be said that characters showing high heritability combined with high genetic advance e.g. fruit weight, fruits/plant, fruit length, locules/fruit, pericarp thickness and vitamin C content could be exploited for improvement thorough selection. In the present study, the characters like number of fruits/plant, fruit length, fruit weight, pericarp thickness, had appreciable direct effects towards fruit yield and proved as important components of fruit yield. The selection based on these characters may result in development of high yielding genotypes.

REFERENCES

1. A.O.A.C. (1984). *Official Methods of Analysis*. Association of Official Analytical Chemist. Washington D.C.
2. Al Jibouri, H.A., Miller, P.A. and Robinson, H.F. (1958). Genotypic and Environmental variances and covariances in an upland cotton cross of interspecific origin, *Agron. J.*, **50** : 633-636.
3. Bharti, A., Jain, B.P., Verma, A.K. and Bharti, O.A. (2002). Genetic variability, heritability and genetic advance in tomato. *J. Res., Birsa Agric. Univ.,* **14**(2): 249-252.
4. Bhushana, H.O., Kulkarni, R.S., Basavarajaiah, D., Halaswamy, B.H. and Halesh, G.K. (2001). Correlation and path analysis for fruit quality traits on fruit yield in tomato. *Crop Res., Hissar*, **22**(1): 107-109.
5. Brar, G.S., Singh, S., Chuma, D.S., Dhaliwal, M.S. and Singh, S. (2002). Studies on variability and genetic advance for yield and component characters in tomato. *J. Res. Punjab Agric. Univ.,* **37**(3-4):190-193.
6. Burton, G.W. and Devana, E.W. (1953). Estimating heritability in tall fescue (*Festuca arundinacea*) from replicated clonal material. *Agron. J.,* **45 :** 468 - 471.
7. Das, B. Hararika, M.H. and Das, P.K. (1998). Genetic variability and correlation in fruit character in tomato. *Annals Agric. Res.,* **19** (1): 70-80.
8. Dewey, D.R. and Lu, K.H. (1959). A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agron. J.*, **15:** 515-518.
9. Dhankar, S.K., Dhankar, B.S. and Sharma, N.K. (2001). Correlation and path analysis in tomato under normal and high temperature condition. *Haryana J. Hortic. Sci.,* **30** (1/2) : 89-92.
10. Domini, M.R. and Moya, C. (1997). Correlation and path coefficient estimates at different

tomato seedling stages. *Cultivos Tropicales,* **18** (3): 63-65.

11. Grafius, J.E.(1965). A geometry of plant breeding. Michigan State University. *Agri. Crop. Sta. Res. Bul.,* **7 :** 59.
12. Hanson, C. H., Robinson, H. F. and Comstock, R.E. (1956). Biometrical studies of yield in segregating population of *Korean lespedeza. Agron. J.,* **47:** 268-272.
13. Harer, P.N., Lad, D.B. and Bhor, T.J. (2003). Correlation and path analysis studies in tomato. *J. Maharashtra Agric. Univ.,* **27** (3): 302-303.
14. Johnson, H.W., Robinson, H.F. and Comstock, R.E. (1955). Estimates of genetic and environmental variability in soybeans. *Agron. J.,* **47**:314-318.
15. Joshi, A., Vikram, A. and Thakur, M.C. (2004). Studies on genetic variability, correlation and path analysis for yield and physiochemical traits in tomato. *Prog. Hort.,* **36** (1): 51-58.
16. Kumar, S., Singh, T., Singh, B. and Singh, J.P. (2004). Studies on heritability and genetic advance in tomato. *Prog. Agri.*, **4**(1): 76-77.
17. Kumar, T.P. and Tewari, R.N. (1999). Studies on genetic variability for processing characters in tomato. *Indian J. Hort.,* **56** (4): 332-336.
18. Kumar, V.R.A., Thakur, M.C. and Hedau, N.K. (2003). Correlation and path coefficient analysis in tomato. *Annals Agric. Res.,* **24** (1): 175-177.
19. Mohanty, B.K. (2002). Studies on variability, heritability, interrelationship and path analysis in tomato. *Annals Agric. Res.,* **23** (1): 65-69.
20. Mohanty, B.K. (2003). Genetic variability, correlation and path coefficient studies in tomato. *Indian J. Agric. Res.,* **37** (1): 68-71.
21. Moya, C., Avarez, M., Bonassy, J., Varela, M. and Mesa, M.E. (1995). Selection of parents, repeatability estimates and correlation in tomato. *Cultivos Tropicales*, **16** (2):79-83.
22. Padma, E., Ravisankar, C. and Srinivasulu, R. (2002). Correlation and path coefficient studies in tomato. *J. Res., ANGRAU*, **30** (4): 68-71.
23. Padmini, K. and Vadivel, E. (1997). Studies on genetic variability and heritability in F_2 generation of tomato. *South Indian Hort.*, 45 (1/2): 1-4.
24. Panse, V. G. and Sukhatme, P. V. (1978). *Statistical Methods for Agricultural Workers*. ICAR, New Delhi,pp.68-75.
25. Phookan, D.B., Talukdar, P., Shadeque, A. and Chakravarty, B.K. (1998). Genetic variability and heritability in tomato. *Indian J. Agric. Sci.*, **68** (6): 304-306.
26. Pujari, C.V., Wagh, R.S. and Kale, P.N. (1995). Genetic variability and heritability in tomato. *J. Maharashtra Agric. Univ.,* **20** (1): 15-17.
27. Ranganna, S. (1997). *Mannual of Analysis of Fruits and Vegetables Products.* Tata Mc. Graw Hill Publ. Co. Ltd., New Delhi.
28. Reddy, V.V.P. and Reddy, K.V. (1992). Studies on variability in tomato. *South Indian Hort.,* **40** (5): 257-260.
29. Sahu, G.S. and Mishra, R.S. (1995). Genetic divergence in tomato. *Mysore J. Agric. Sci.,* **29** (1): 5-8.
30. Sharma, K.C. and Verma, S. (2000). Path coefficient analysis in tomato. *Indian J. Agric. Sci.,* **70** (10): 700-702.
31. Singh, B., Singh, S.P., Kumar, D. and Verma, H.P.S. (2001). Studies on variability, heritability and genetic advance in tomato. *Prog. Agric.*, **1**(1):76-78.
32. Singh, D.N., Sahu, A. and Parida, A.K. (1999). Genetic variability and correlation studies in tomato. *Env. and Ecol.,* **15** (1): 117-121.
33. Singh, J.K., Singh, J.P., Jain, S.K. and Aradhana, Joshi. (2004). Correlation and path coefficient analysis in tomato. *Prog. Hort.*, **36** (1): 82-86.
34. Singh, Y. (1999). Estimates of genetic variability and heritability on yield and some biochemical traits in tomato. *Scientific Hort.*, **6** :85-88.
35. Vikram, A. and Kohli, U.K. (1998). Genetic variability, correlation and path analysis in tomato. *J. Hill Res.,* **11**(1): 107-111.
36. Yadav, D.S. and Singh, S.P. (1998). Correlation and path analysis in tomato. *J. Hill Res.,* 11(2): 207-211.

HortFlora Research Spectrum, 1(2): 117-121 (2012) ISSN : 2250-2823

EFFECT OF DIFFERENT PACKAGINGS ON QUALITY OF PEACHES DURING STORAGE

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ABSTRACT: Physiochemical and enzymatic changes in the peach fruits packed in corrugated cardboard boxes of 2 kg and 4 Kg and traditional wooden boxes of 4 Kg and 8 Kg were studied during cold storage (0-2°C with 85-90 per cent R.H.). The CFB boxes was proved very effective in reducing spoilage, physiological loss in weight (PLW) and maintaining acidity, total phenols content and pectin methyl estrase (PME) activity during storage. There was an increase (p 0.05) in spoilage, PLW, TSS, reducing sugars and PME activity and decrease (p 0.05) in acidity and total phenols content during storage. The fruits packed in 2 kg CFB boxes were best in terms of quality parameters followed by 4 kg CFB boxes. Results revealed that peach fruits packed in 2 kg CFB boxes can be stored for three weeks in cold storage (0-2°C, 85-90% RH) with acceptable edible quality of fruits and can be substituted for wooden boxes due to its demonstrated benefits.

Keywords : *Peach, packaging, quality, storage.*

Peaches are climacteric fruits with short post harvest life due to its high moisture content and relatively high metabolic activity during post harvest phase. It has a shelf life of 3-5 days under ordinary conditions of storage (Tonini and Tura, 19). Major quality indices for peach include colour, size, firmness and freedom from defects and decay (Kader and Mitchell, 5; Lill *et al.,* 6 and Mitchell *et al.,* 11). Mechanical damage is one of the major causes of the quality loss of peach fruit, therefore, proper packaging is demanded for better protection and shelf life extension while keeping the product in optimal storage conditions. Cold storage is widely used to reduce respiration rate, ethylene production and extend the shelf life of fruits. The packaging and storage environment greatly affect the postharvest storage life and quality of fruits (Malakou and Nanos, 9 and Wijewardane and Guleria, 20). So the aim of present study was to detect the comparative effect of two different packagings in maintaining the fruit quality of 'Earli Grande' peaches during cold storage.

MATERIALS AND METHODS

The peach fruits (cv. Earli Grande) of uniform size and ripening were harvested and pre-cooled to remove field heat. The fruits were air dried and packed in corrugated fibre board (CFB) containers/boxes of 2 kg (5 ply; 30cm x 20.5cm x11cm size) and 4 kg(5 ply; 30cm x 20.5cm x 22 cm size); wooden boxes of 4 kg (34.5cm x 19cm x 15.5cm) and 8 kg (48cm x 19cm x 18.5cm). Fruits were placed in 3 or 4 layers after placing paper strip at base and newspaper sheets on the sides of the boxes. Each layer of fruits was separated with paper strips. Packed fruits were kept in cold storage at temperature of 0-2°C with 85-90 per cent relative humidity. The physico-chemical changes in the fruits were assessed weekly for 3 weeks of storage. The physiological loss in weight of fruits, spoilage, TSS, acidity, total sugar content, total phenols, reducing sugars and pectin methyl esterase activity were recorded. The spoilage percentage of fruit was calculated on number basis by counting the fruits from each box that had spoiled during storage. The physiological loss in weight (PLW) of the fruit was calculated on initial weight basis and expressed in per cent. TSS were recorded with the help of a hand refractometer (Erma Japan) with correction at 20°C. The acidity, reducing sugars, total sugars and total phenols (AOAC, 1) and pectin methyl esterase (PME) (Mahadevan and Sridhar, 7) were estimated. Analysis of variance (ANOVA) and the test of mean comparison according to critical difference (CD) were applied. Significance level was accepted

Received : 05.1.2012 *Accepted : 6.2.2012*

at p 0.05. The data of 3 replications was analyzed statistically by Factorial analysis in a randomized block design using CPCS1 software as a statistical analysis tool (Cheema and Singh, 2).

RESULTS AND DISCUSSION

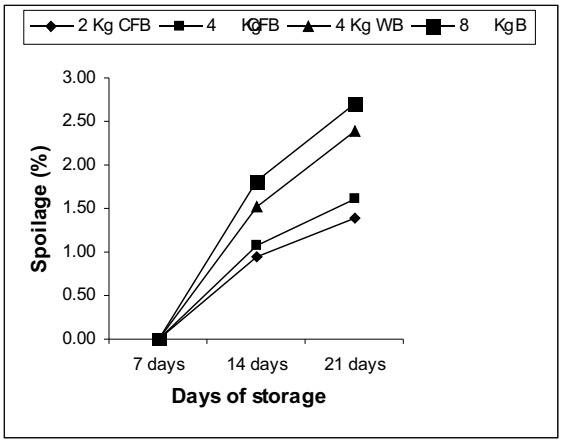
Spoilage: Fruits packed in 2 kg CFB boxes showed lower (p 0.05) spoilage than wooden boxes (Fig. 1). Maximum spoilage was observed in fruits packed in 8 Kg wooden boxes followed by 4 Kg wooden boxes. Lesser bruising and proper ventilation in CFB boxes as compared to wooden boxes may have resulted in least spoilage. Big size boxes resulted in high intensity of bruising as more fruits may have come in contact with each other. Sharma and Singh (16) also reported lesser spoilage in apples packed in CFB boxes as compared to wooden boxes. The increase in spoilage with the advancement of storage period may be attributed to progressive decrease in fruit firmness due to hydrolysis of metabolites when the fruits were stored for a longer period. The present findings are also in agreement with those of Saini *et al.* (15).

Physiological loss in weight: The PLW was observed 5.83% in 2 kg CFB boxes during 3 weeks of storage and was lowest compared to other packaging. The fruits packed in wooden boxes of 8 kg recorded maximum PLW. The lesser loss in weight of fruits packed in CFB boxes may be attributed to the build up of higher humidity conditions inside the boxes resulting in lesser loss of net weight of fruits. Wooden boxes showed maximum loss due to moisture absorption by the timber from the fruits and subsequent loss of this moisture to the atmosphere. Similar findings were reported for apple by Sidhu *et al.* (17) and Thakur and Lal (18). The loss in weight during the storage was significant regardless of packaging. An increase in PLW in all packaging with period of storage was obvious as the different physiological process, like transpiration and respiration, continued in fruits even after harvest.

Total Soluble Solids: The fruits packed in wooden boxes showed their superiority (p 0.05) over the fruits packed in CFB boxes. Fruits packed in 8 kg and 4 kg wooden boxes had higher TSS of 13.72% during 3 weeks of storage. The higher TSS content in fruits packed in wooden boxes in comparison to CFB boxes may be ascribed to the increases in PLW, increased metabolic activities and partly by hydrolysis of starch, which resulted in disappearance of starch, associated with the increase in TSS. The increase in TSS with the advancement in storage period may probably be due to starch gets hydrolyzed into mono and disaccharides which in turn may lead to an increase in total soluble solids (Mohsen, 12).

Acidity: The acidity of fruits packed in CFB boxes and wooden boxes ranged from 0.54 to 0.59 during 3 weeks of storage, recorded higher (p 0.05) in CFB boxes (Fig. 1). Relatively low decrease in acid content of fruits under better packing in CFB boxes might affected slower rate of ethylene production. Maximum decrease in acidity of fruits packed in wooden boxes may be ascribed to increased respiration rate and more utilization of acids in bio-chemical activities leading to depletion of organic acids. Meena *et al.* (10) in ber have reported the similar results that the fruits packed in CFB boxes maintained higher acidity. Acid content of the fruits decrease with an increase in storage interval. Reduction in acidity during storage might be due to the increased catabolism of organic acids present in fruit through the process of respiration. The results of the present study were in accordance with the earlier findings of Dris and Blanke (3).

Total sugars content: The total sugars content of fruits packed in wooden boxes was higher (p 0.05) than the fruits packed in CFB boxes. Fruits packed in 8 kg wooden boxes recorded the total sugars content of 9.91% after 3 weeks of storage. The improved sugar contents of fruits in wooden boxes might be result of rapid loss of moisture and fast hydrolysis of starch and other polysaccharides to soluble form of sugars. The lower levels of total sugars in CFB boxes had also been reported earlier in ber by Radder *et al.* (14). There was also an increase in total sugars content



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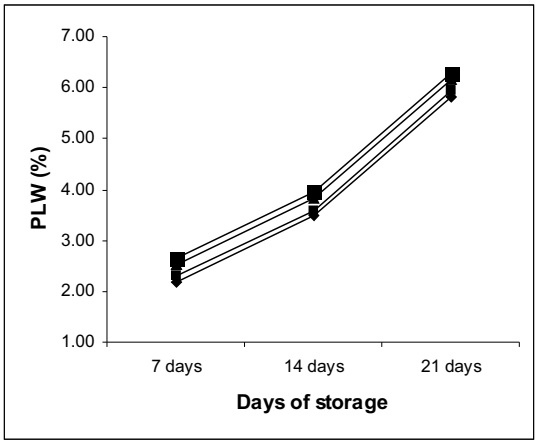

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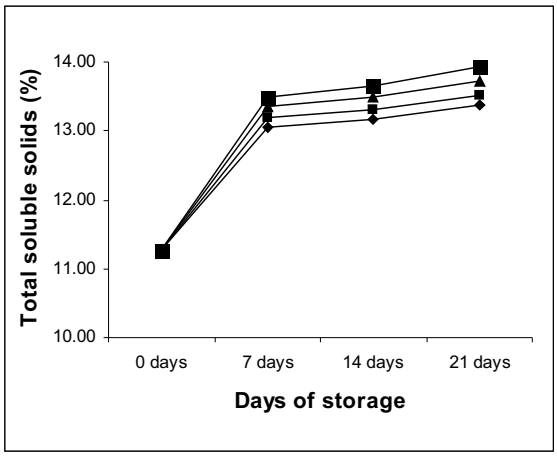

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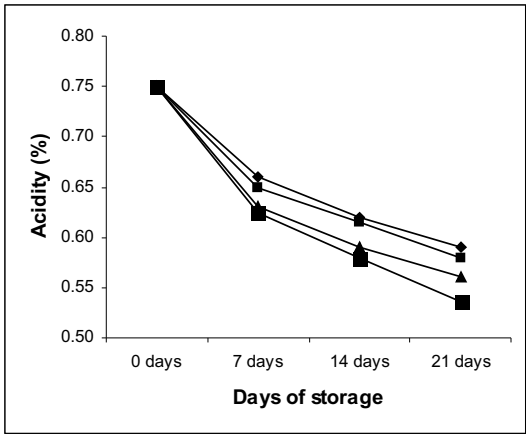


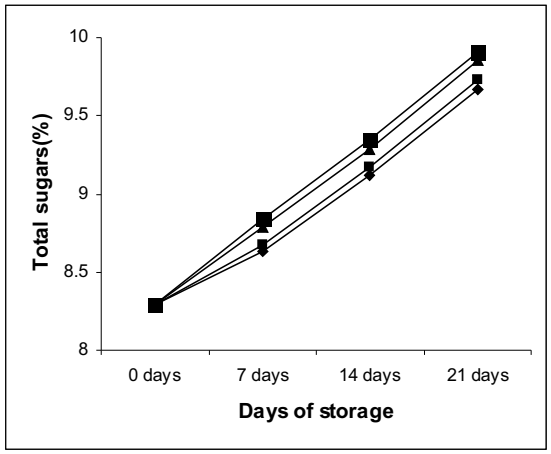
CD: T=0.008, S=0.005, TXS=0.011

Fig. 1. Changes in quality parameters of peach fruit packed in 2kg CFB, 4Kg CFB, 4Kg Wooden boxes and 8Kg Wooden box during cold storage at 0-2°C, 85-90% RH for 3 weeks (n = 3) in Spoilage (%),PLW (physiological loss in weight), Total soluble solids (%) and acidity (%). (T-treatment, S-storage, CD = Significant at P 0.05)

with the increase in storage interval. However, within different type of boxes influence of their sizes was at par. The packaging material exerted a significant influence on the total sugars of peach fruits during storage.

Total phenol content: Total phenol content was higher (0.22%) in fruits packed in 2 kg CFB boxes and 4 kg CFB boxes during 3 weeks of storage (Fig. 2). The total phenol content were significantly lower in 8 kg wooden boxes which might be a result of increased polyphenol oxidase activity in wooden boxes as compared to CFB boxes. There was a decrease in total phenol content of peach fruits with increase in storage periods. The total phenol content decline with advancement of storage and this loss of astringency is probably connected with increased polymerization of tannins. The results are in agreement with the findings of Mahajan (8) in apples.

Reducing sugars: The fruits packed in 2 kg CFB boxes recorded significantly lower reducing sugars of 6.92% after 3 weeks of storage whereas



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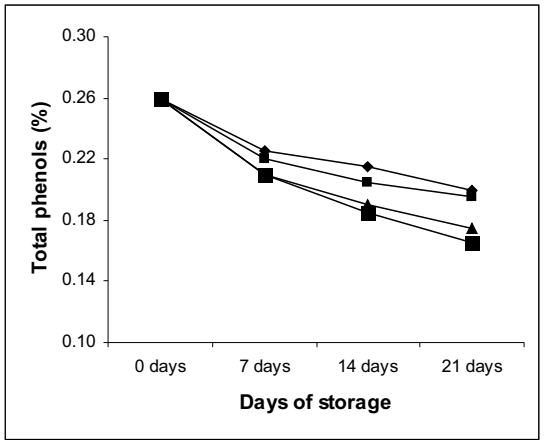

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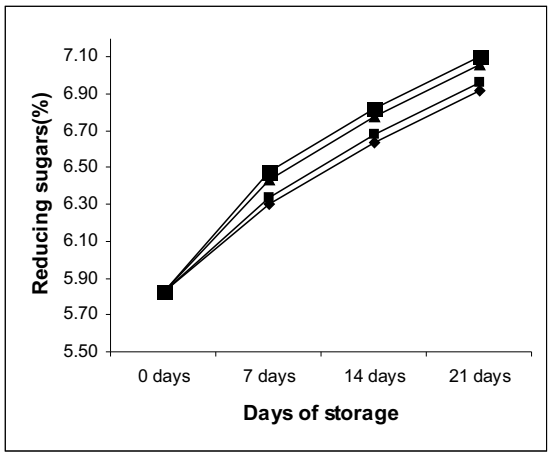
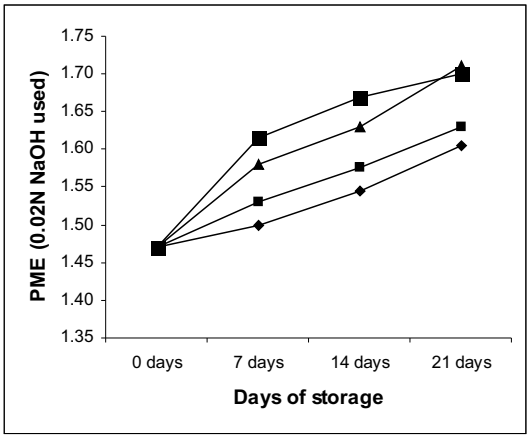


CD: T=0.007, S=0.004, TXS=0.008



CD: T=0.002, S=0.006, TXS=0.011

Fig. 2. Changes in quality parameters of peach fruit packed in 2kg CFB, 4Kg CFB, 4Kg Wooden boxes and 8Kg Wooden box during cold storage at 0-2°C, 85-90% RH for 3 weeks (n = 3) Total sugars, Total phenols, Reducing sugars and PME (pectin methyl esterase). (T-treatment, S-storage, CD = Significant at P 0.05)

the fruits packed in 8kg wooden boxes recorded maximum (7.11%) reducing sugar after same storage interval. Higher level of reducing sugars in fruits packed in wooden boxes in comparison to CFB boxes might be due to the more moisture loss and faster rate of metabolic activities in wooden boxes resulting in breakdown of starch into sugars. The constant increase in the reducing sugar with storage is suggestive of the conversion of starch and possibly of other organic acids and amino acids into reducing sugars. Similar changes in reducing sugar content were also reported by Prasant and Masoodi (13).

Pectin Methyl Esterase activity: The type of packaging materials had (p 0.05) influence on the PME activity of peach fruits (Fig. 2). The fruits packed in 2 Kg CFB boxes showed lower PME activity of 1.61 after 3 weeks of storage whereas the fruits packed in 8 Kg wooden boxes recorded maximum PME activity (1.71) after same storage interval. The PME activity increased during storage irrespective of packaging material. An increase in

PME activity during storage was also observed by Gupta *et al.* (4).

Conclusions

Peach fruits packed in ventilated corrugated fibre board boxes (2 kg) can be stored with acceptable edible quality for three weeks in cold storage at 0-2°C and 85-90% RH and can be substituted for wooden boxes due to its demonstrated benefits.

REFERENCES

1. A.O.A.C. (2000). *Official Methods of Analysis.* 15th Edition, Washington, DC, USA.
2. Cheema, H.S. and Singh, B. (1990). *A user's manual to CPCSI-A computer programme package for analysis and commonly used experimental designs.* Punjab Agricultural University, Ludhiana, India
3. Daris, S. and Blanke, M. (1998). Post harvest quality of apples grown in the Aland Islands. *Acta Hort.* **466**:35-40.
4. Gupta, N., Jawandha, S.K. and Gill, P.S. (2011). Effect of calcium on cold storage and post-storage quality of peach. *J. Food Sci. Tech.,* **48:** 225-229.
5. Kader, A.A. and Mitchell, F.G. (1989). Postharvest physiology. In: La Rue JH, Johnson RS (eds) *Peaches, Plum and Nectarines: Growing and Handling for fresh market*. University of California Department of Agriculture and Natural Resources Publication No. 3331: 158-164.
6. Lill, R.E., O'Donoglue, E.M. and King, G.A. (1989). Post harvest physiology of peaches and nectarines. *Hortic. Reviews,* **11:** 413-452.
7. Mahadevan. A. and Sridhar, R. (1982). *Methods in physiological plant pathology*, Sivagami Pub. Madras.
8. Mahajan, B.V.C. (1994). Biochemical and enzymatic changes in apple during cold storage. *J. Food Sci. Technol,* **31:** 142-144.
9. Malakou, A. and Nanos, G.D. (2005). A combination of hot water treatment and modified atmosphere packaging maintains quality of advanced maturity 'Caldesi 2000' nectarines and 'Royal Glory' peaches. *Postharvest Biol. and Tech.,* **38:** 106-114.
10. Meena, H.R., Kingsly, A.R.P. and Jain, R.K. (2009). Effect of post-harvest treatments on shelf life of ber fruits. *Indian J. Hort.,* **66**:58-61.
11. Mitchell, F.G., Meyer, G. and Biassi, W. (1990). Handling high quality stone fruit. In: Final Report, *California Tree Fruit Agreement.*
12. Mohsen, A.T. (2011). Performance of peach and apricot fruits at cold storage and shelf life as affected by modified atmosphere packaging. American-Eurasian *J. Agric. & Environ. Sci.*, **10**: 718-727.
13. Prasant, B. and Masoodi, F.A. (2009). Effect of various storage conditions on chemical characteristics and processing of peach cv. 'Flordasun'. *J. Food Sci. Tech.,* **46:** 271-274.
14. Radder, Y.B., Patil, H.B., Patil, D.R. and Mantur, S.M. (1998). Studies on suitable package for transportation of 'ber' cv. Umran. *Adv. Agric. Res.* India, **10:** 65-69.
15. Saini, R.S., Chanana, Y.R. and Singh, G. (2001). Crop regulation effects on the cold storage of peaches. Effect on physical characteristics of fruits. *Haryana J. Hortic. Sci*. **30:** 177-181.
16. Sharma, R.R. and Singh, D. (2010). Effect of different packaging material on shelf-life and quality of apple during storage. *Indian J. Hort.,* **67:** 94-101.
17. Sidhu, G.S., Dhillon, W.S. and Mahajan, B.V.C. (2009). Effect of waxing and packaging on storage of pear cv. Punjab Beauty. *Indian J. Hort.*, **66:** 239-244.
18. Thakur, N.S. and Lal, B.B. (1989). Evaluation of Plastic carton and corrugated fibre board carton vis-a-vis conventional wooden box for packaging and transportation of apple. *J. Food Sci. Tech.,* **26:** 239-41.
19. Tonini, G. and Tura, E. (1998). Influences of storage and shelf-life time on rots of peaches and nectarines. *Acta Hort.,* **464**:364-367.
20. Wijewardane, R.M.N.A. and Guleria, S.P.S. (2009). Combined effects of pre-cooling, application of natural extractants and packaging on storage quality of apple (*Malus domestica*) cv. Royal Delicious. *Tropical Agri. Res.,* **21:** 10-20.

HortFlora Research Spectrum, 1(2): 122-126 (2012) ISSN : 2250-2823

GENETIC VARIABILITY AND CORRELATION ANALYSIS IN BER (*Zizyphus mauritiana* Lamk.) GERMPLASM GROWN IN LUCKNOW

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ABSTRACT: A study was conducted in sodic soil conditions of Lucknow during 2005-2006 using 16 genotypes of *Zizyphus mauritiana* Lamk. in which 12 were commercial cultivars viz. Banarasi Karaka, Karali, Shootless, Mehrun, Peundi, Gola, Jaffran, Chhuhara, Khinni, Desi, Kaithli and Illaichi; and 4 selections-i.e. Ambedkar Ber 1, Ambedkar Ber-2, Ambedkar Ber-3 and Ambedkar Ber-4 to correlate 13 physico-chemical characters of fruits i.e. fruit length, fruit width, fruit weight, fruit volume, specific gravity, total soluble solid (TSS), acidity, ascorbic acid, stone length and stone width, stone weight, pulp: stone ratio and fruit pulp. The experiment was carried out in completely randomized design (CRD) with three replications. Correlation analysis study showed a high positive and statistically significant (P<0.01) correlation between fruit pulp and fruit weight (0.999). Fruit pulp also had positive and significant correlation with fruit volume (0.874) and fruit width (0.730). Fruit volume indicated negative correlation with specific gravity. Therefore, information on different physico-chemical characters of fruits and fruit pulp yield may be of great importance to a breeder in selecting a desirable genotype.

Keywords: *Ber, genetic variability, correlation analysis, physico-chemical characters.*

Indian jujube or ber (*Z. mauritiana* Lamk.), belongs to the family Rhamnaceae, consists of 45 genera and 550 species. The genus *Zizyphus* has approximately 40 species, including *Zizyphus mauritiana* Lamk.(Indian jujube). It is one of most ancient and common fruits in India (Rai and Gupta, 10). The ber fruits has a high sugar content and a high level of vitamins A & C, carotene, phosphorus and calcium. It is an excellent source of ascorbic acid and carotenoids. Ber can provide food security, due to sustained production of the fruit, irrespective of drought, as the tree is drought and saline tolerant and can grow on poor and degraded land. It is widely distributed in tropical and subtropical climates in the world (Mukhtar *et al*., 7). The fresh fruit has a mild sub-acid flavour and crisp firm flesh. It is used for preparation of murrabba, candy, pickles, preserve, canned ber and chutney (Singh, 14) and pulp is used for making jam (Neog *et al*., 8). *Jujube* is both a delicious fruit and an effective herbal remedy. The dried fruits are stomachic, styptic and tonic considered to purify the blood and aid digestion (Chopra *et al.*, 4). They are used internally in the treatment of chronic fatigue, loss of appetite, diarrhoea, anaemia, irritability and hysteria (Bown, 3). The study of physico-chemical characteristics of different ber cultivars are of great value in assessing its potentiality for fruit improvement programme through hybridization for which systematic and sustained research needs to be carried out of all the aspects of commercial cultivation including basic studies to meet the challenges of 21st century (Kumar, 5). Ber demonstrates a rich genetic diversity mostly resulting from natural cross-pollination and self-incompatibility (Bhargava *et al.,* 2). Thus, it is necessary to select desired genotypes for superior fruit characteristics and to develop standard cultivars from a wide variety of natural population.

MATERIALS AND METHODS

Present investigations were carried out during year 2005-2006 in the Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University, Lucknow. It is situated within the sub tropical tract of central U.P. at 26° 56' N altitude and 80° 52' E longitude at an

Received : 29.3.2012 *Accepted : 16.4.2012*

Table 1: Genetic variability for physico-chemical characters of ber.

Characters	**Mean ± SD**	Range
Fruit length	3.968 ± 0.127	1.51-5.56
Fruit width	2.690 ± 0.113	1.01-3.56
Fruit weight	19.385 ± 1.156	0.98-28.65
Fruit volume	16.583 ± 1.469	1.00-25.00
Specific gravity	1.225 ± 0.071	0.53-2.89
T.S.S.(%)	14.000 ± 0.246	8.00-20.00
Acidity	5.667 ± 0.355	1.60-9.50
Ascorbic acid	6.243 ± 0.421	1.80-8.40
Stone length	2.480 ± 0.083	1.11-3.49
Stone width	0.657 ± 0.018	0.41-1.30
Stone weight	0.795 ± 0.049	0.06-3.42
Pulp:Stone ratio	23.660 ± 1.158	3.45-65.35
Fruit pulp	18.590 ± 1.118	0.79-25.17

elevation of 1100 meter above mean sea level. 12 commercial cultivars of ber Banarasi Karaka, Karali, Shootless, Mehrun, Peundi, Gola, Jaffran, Chhuhara, Khinni, Desi, Kaithli, Illaichi, and 4 selections Ambedkar Ber-1, Ambedkar Ber-2, Ambedkar Ber-3 and Ambedkar Ber-4 were selected for this experiment. Fruits were collected at fully ripe stage and experiment was carried out in Completely Randomized Design (CRD) with three replications. Observations were recorded on some physical characters viz. fruit length, fruit width, fruit volume, specific gravity, stone length and stone width, stone weight, pulp:stone ratio, fruit pulp and biochemical characters viz. total soluble solid (TSS%), acidity (%) and ascorbic acid by taking twelve healthy and uniformly ripe fruits randomly from each genotype. Data on length and width of fruit and stone were recorded using Vernier callipers, weight by using digital balance and volume by water displacement method. Total soluble solid of the fruit was recorded directly with the help of hand refractometer (ERMA, Japan 0-30 °Brix), whereas acidity and ascorbic acid were recorded using standard methods as described by (Ranganna, 11). The Simple Correlation Coefficients between all possible combinations of variables were worked out using OPSTAT windows by (Sheoran, 12).

RESULTS AND DISCUSSION

The analysis of variance revealed the significant difference among the genotypes for all the traits studied indicating that there is substantial genetic variability for these traits. The mean values and range for all the fruit traits (Table 1) showed considerable variation in morphological and physico-chemical characters of fruits. Fruit length ranged from 1.51-5.56 with mean value 3.968. Range for fruit width, fruit weight, fruit volume, specific gravity, total soluble solid (TSS %), acidity (%), ascorbic acid, stone length and stone width, stone weight, pulp:stone ratio and fruit pulp were 1.01-3.56, 0.98-28.65, 1.00-25.00, 0.53-2.89, 8.00-20.00, 1.60-9.50, 1.80-8.40, 1.11-3.49, 0.41- 1.30, 0.06-3.42, 3.45:1-65.35:1 and 0.79-25.17 with mean values 2.690, 19.385, 16.583, 1.225, 14.000, 5.667, 6.243, 2.480, 0.657, 0.795, 23.660, 18.590, respectively. Genotype Mehrun had highest fruit weight (21.82 g), fruit volume (21.79 cc), fruit pulp (21.21 g) and pulp:stone ratio (36.98).

The results of the correlation coefficient analysis (Table 2) revealed that a high, positive and significant correlation ($P<0.01$) was observed between fruit pulp and fruit weight (0.999), between fruit pulp and fruit volume (0.874) and between fruit pulp and fruit width (0.730). Fruit weight had positive and significant correlation with fruit volume (0.871) and fruit width (0.729) and fruit volume had negative and significant correlation with specific gravity (-0.804) at $P<0.01$. There was a statistically significant ($P<0.05$) and positive correlation between fruit volume and stone weight (0.618), fruit volume and fruit length (0.586) and fruit volume and fruit width (0.611). Fruit volume had negative and significant correlation with total soluble solids (-0.524) at $P<0.05$. Therefore, study of physico-chemical characteristics of different ber cultivars are of great value in assessing its potentiality for fruit improvement programme through hybridization for which systematic and sustained research needs to

Table 2: Genotypic means for 13 physico-chemical characters in 16 genotypes of ber.

Genotypes	Fruit length (cm)	Fruit width (cm)	Fruit weight (g)	Fruit volume (ml)	Specific gravity (g/cc)	T.S.S. (%)	Acidity (%)	Ascorbic acid (mg/100g)	Stone length (cm)	Stone width (cm)	Stone weight (g)	Pulp: Stone ratio	Fruit Pulp (g)
Banarasi Karaka	3.968	2.690	19.385	16.583	1.225	14.000	5.667	6.243	2.480	0.656	0.795	23.660	18.590
Karali	5.113	2.648	20.169	18.083	1.130	13.66	8.500	5.568	2.828	0.694	2.805	6.500	17.363
Shootless	3.613	2.523	10.420	8.708	1.315	10.50	2.633	3.668	2.116	0.608	0.549	18.618	9.872
Mehrun	4.613	2.932	21.821	21.792	1.005	13.000	2.633	3.667	2.299	0.681	0.607	36.978	21.210
Peundi	3.530	2.345	9.467	8.541	1.198	10.000	2.867	5.843	2.233	0.620	0.573	16.043	8.893
Gola	2.994	2.480	9.712	9.166	1.075	17.333	3.200	4.600	1.710	0.710	0.588	16.452	9.12
Jaffran	4.254	2.949	20.788	16.417	1.361	15.000	3.700	4.943	2.384	0.794	0.870	23.613	19.92
Chhuhara	3.108	2.289	10.058	9.042	1.171	15.667	2.800	4.943	2.063	0.764	0.635	15.385	9.42
Khinni	2.305	1.699	2.435	2.750	0.947	9.333	1.800	3.678	1.564	0.518	0.123	22.790	2.31
Desi	2.413	2.596	6.189	5.583	1.990	19.333	6.800	5.022	1.323	0.922	0.613	9.258	5.58
Kaithali	2.053	1.752	4.179	2.375	2.006	16.000	7.167	4.143	1.487	0.858	0.638	5.993	3.54
Illaichi	3.423	2.259	9.912	7.750	1.34	13.333	3.600	3.702	2.176	0.559	0.576	17.493	9.35
Ambedkar Ber 1	1.505	1.511	2.443	2.625	0.933	15.667	6.767	5.578	0.869	0.606	0.246	9.038	2.20
Ambedkar Ber 2	1.988	1.648	3.848	2.583	1.68	12.333	6.967	5.633	1.179	0.684	0.386	9.667	3.46
Ambedkar Ber 3	2.284	1.591	4.198	2.917	1.447	12.333	9.600	4.200	1.439	0.426	0.683	5.028	3.50
Ambedkar Ber 4	2.305	2.433	7.757	6.923	1.16	17.333	8.270	4.523	1.215	0.911	0.781	9.064	6.98

Table 3: Correlation coefficients for 13 physico-chemical characters of ber (*Zizyphus mauritiana* Lamk.).

Chatacters	Fruit length	Fruit width	Fruit weight	Fruit volume	Specific gravity	T.S.S. (%)	Acidity (%)	Ascorbic acid	Stone length	Stone width	Stone weight	Pulp:Stone ratio	Fruit Pulp
Fruit length	1.000	0.366	0.599*	0.586*	-0.417	-0.141	-0.365	-0.433	0.425	0.089	0.392	0.337	0.602*
Fruit width		1.000	0.729**	0.611*	-0.310	-0.391	-0.374	0.022	0.712**	0.247	0.540*	0.182	0.730**
Fruit weight			1.000	0.871**	-0.442	-0.381	-0.202	-0.380	0.740**	0.236	0.789**	0.284	0.999**
Fruit volume				1.000	-0.804**	-0.524*	-0.133	-0.212	0.444	-0.043	0.618*	0.393	0.874**
Sp. gravity					1.000	0.600*	0.157	-0.107	0.019	0.285	-0.235	-0.362	-0.446
T.S.S. (%)						1.000	0.00	-0.176	-0.078	0.180	-0.044	-0.475	-0.392
Acidity (%)							1.000	-0.135	-0.342	-0.179	-0.142	-0.065	-0.203
Ascorbic acid								1.000	-0.123	-0.082	-0.143	-0.443	-0.387
Stone length									1.000	0.329	0.806**	-0.168	0.730**
Stone width										1.000	0.451	-0.415	0.225
Stone weight											1.000	-0.354	0.772**
P:S ratio												1.000	0.309
Fruit Pulp													1.000

*Significant at 5% level; **Significant at 1% level.

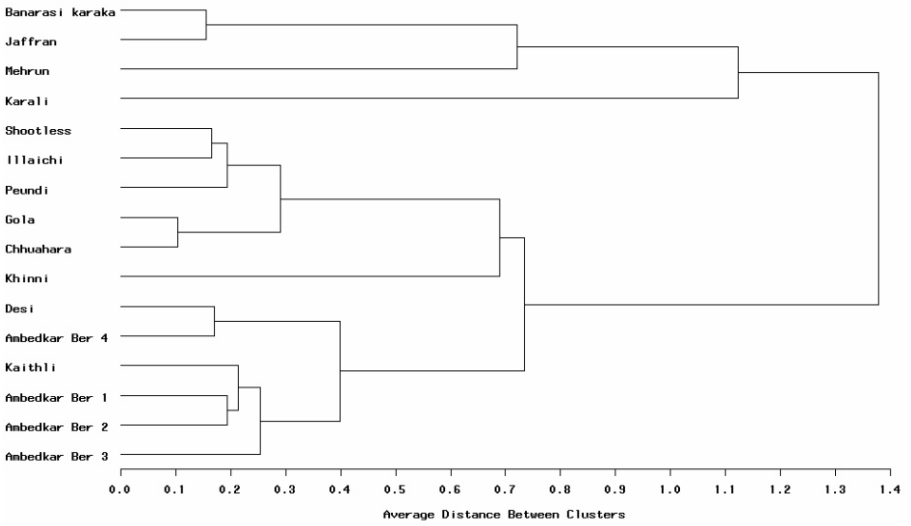

Fig. 1: Average distance between mean clusters of ber genotypes.

be carried out of all the aspects of commercial cultivation. Characters like fruit width, fruit weight and fruit volume are the yield contributing character for improvement of pulp yield in ber. Similar associations between traits studies have also been reported by Thimmappaiah *et al.* (13) and Kurmi (6) in guava, Attri *et al.* (1) in mango and Patil and Patil (9) in grape.

CONCLUSIONS

On the basis overall performance, four genotypes Mehrun, Jaffran, Karali and Banarasi Karaka were found more suitable in respect of fruit weight (21.82, 20.79, 20.17 and 19.39, respectively), T.S.S. (13.00, 15.00, 13.67 and 14.00 °Brix), ascorbic acid (3.67, 4.94, 5.57 and 6.24, respectively), pulp: stone ratio (36.98, 23.61, 6.50 and 23.66, respectively) and fruit pulp (21.21, 19.92, 17.36 and 18.59) for cultivation under sodic soil condition of Lucknow.

Fruit pulp yield can be increased by selecting genotypes having higher fruit width, fruit weight and fruit volume and for hybridization parents can be selected on basis of fruit width, fruit weight and fruit volume, which are counted as yield contributing characters for fruit pulp yield for attaining commercial cultivation of Ber.

Acknowledgements

Authors are grateful to the Department of Applied Plant Science (Horticulture), BBAU, Lucknow, for providing laboratory facility and technical assistance for the experiments.

REFERENCES

1. Attri, B.L., Sharma, T.V.R.S., Singh, D.B. and Nagesh, P. (1999). Genetic variability and correlation studies in mango collections of South Andaman. *Indian J. Hort.,* **56 :** 144-48.
2. Bhargava, R., Shukla, A.K., Chauhan, N., Vashishtha, B.B. and Dhardar, D.G. (2005). *Environ. and Experi. Bot.,* **53**(2): 135-138.
3. Bown, D. (1995). *Encyclopaedia of Herbs and their Uses.* Dorling Kindersley, London. ISBN 0-7513-20-31.
4. Chopra, R.N., Nayar, S.L. and Chopra, I.C. (1986). *Glossary of Indian Medicinal Plants* (*Including the Supplement*). Council of Scientific and Industrial Research, New Delhi.
5. Kumar, S. (2003). Physico-chemical studies on litchi (*Litchi chinensis* Sonn.) cultivars. *M.Sc. Thesis* submitted to B.B.A. University, Lucknow.
6. Kurmi, S.P. (1992). Studies on physical and chemical characterization of guava (*Psidium*

guajava L.) cultivars grown in Rewa. *M.Sc. (Ag.) thesis* submitted to JNKVV, Jabalpur.

7. Mukhtar, H. M., Ansari, S. H., Ali, M. and Naved, T. (2004). New compounds from *Zizyphus vulgaris. Pharmaceutical Bio.,* **42**(7): 508-511
8. Neog, M., Mohan, N.K. and Baruna, P.C. (1993). Physico-chemical changes during growth and development of local ber (*Zizyphus jujube* Mill.) fruit of Assam. *Haryana J. Hortic. Sci.,* **22**(1):121-125.
9. Patil, S.G. and Patil, V.P. (1995). Correlatin and path analysis in grapes. *Indian J. Hort.,* **52** : 250-53.
10. Rai, M. and Gupta, P.N. (1994). Genetic diversity in fruits of ber. *Indian Hort.*, I.C.A.R. New Delhi, (April-June 10-51p)
11. Ranganna, S. (1996). *Handbook of analysis and quality control for fruits and vegetable* production (2nd Edition). Tata McGraw Hill Publishing Company.
12. Sheoran, O.P. (2002). *Statistical Package for Agricultural Research Workers*, CCS, HAU, Hissar.
13. Thimmappaiah, Yadav, I.S. and Suman, C.L. (1985). Genetic variability and association analysis in guava. *Indian J. Agric. Sci.,* **55:** 679-82.
14. Singh, S. P. (1995). *Commercial Fruits.* Kalyani Publishers.

**Paper is the part of M. Sc. thesis submitted to DAPSH, BBAUniversity, Lucknow.*

HortFlora Research Spectrum, 1(2): 127-130 (2012) ISSN : 2250-2823

EMBRYO CULTURE AND DEVELOPMENT OF SEEDLINGS IN DIFFERENT *CITRUS SPECIES*

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ABSTRACT: The citrus industry is considered to be a major fruit industry hence it needs to be improved to cater to the diverse needs of consumers and crop breeders. Genetic manipulation through conventional techniques in this genus is invariably a difficult task for plant breeders as it poses various biological limitations comprising long juvenile period, high heterozygosity, sexual incompatibility, nucellar polyembryony and large plant size that greatly hinder cultivar improvement. The demands for elite rootstock material are continuously increasing for fruit production and to fulfill such demands application of *in vitro* propagation techniques is one of the successful alternative particularly in case of citrus crops. One of the essential requirements for the successful application of plant propagation technology in agriculture is its capacity to regenerate elite plantlets. The process of embryo culture is a suitable method of micropropagation and has the potential of mass propagation commercially. Keeping in mind these things experiment on "Embryo culture and development of seedlings in different *Citrus species*" was conducted. The seeds were extracted from the developing fruits from the trees growing in the college nursery and were sterilized. The embryos of six *Citrus species* were cultured to obtain the stock plants. The germination ranged from 71.5 to 96.0 per cent and the embryos were inoculated on the basal Murashige and Skoog medium. *Citrus limon* gave the maximum (96 per cent) germination and *Citrus sinensis* resulted in minimum (71.5 per cent) germination. It was concluded from the experiment that *in vitro* propagation has been a great potential tool to overcome problems related with the field culture for citrus species. These advances in biotechnology have generated new opportunities for citrus genetic improvement. Therefore, development of efficient embryo culture protocols is necessary for conservation and genetic improvement of citrus.

Keywords : *Citrus sp., embryo culture, germination.*

Citrus is highly popular crop among the masses and is commercially cultivated for its processing quality, fresh consumption and aromatic flavour. Despite its cultivation on large areas, citrus plantation still has some problems such as slow growth, long juvenility, insect pests, diseases, alternate bearing, pre and post harvest losses, large number of seeds per fruit, short season of supply and short storage life etc. Traditional genetic plant improvement offers limited scope for the production of new varieties of scion and root stocks and the new varieties produced so far were originated form natural selection and mutations. Advances in the field of biotechnology have generated new opportunities for citrus genetic improvement. One of the essential requirements for the successful application of plant propagation technology in agriculture is the capacity to regenerate elite plantlets (Karwa and Chikhale, 6). The demand for elite rootstock material are continuously increasing and to fulfill such demands, application of *in vitro* propagation technique is the only alternative way. *In vitro* propagation has therefore been a great potential tool to overcome problems related with the field culture for such species. The process of embryo culture is a suitable method of micropropagation and has the potential of mass propagation commercially. Usefulness of citrus rootstocks for the improvement of canopy architecture, fruit production, quality and tolerance to biotic and a-biotic stresses of citrus crops is well known. However these rootstocks, propagated by growing open-pollinated seeds, are highly nucellar and produce true to type plants. Depending upon the rootstocks, generally 1 to 40% zygotic seedlings

Received : 4.1.2012 *Accepted : 6.2.2012*

are produced, which must be culled from seed beds to maintain clonal uniformity. All citrus cultivar selections are usually grafted to selected rootstock seedlings. Some potentially valuable rootstocks produce few or no seed and thus seed shortage of such popular rootstock occurs periodically. Further, the demand of quality planting material of important rootstocks in ample number necessitates for their *in vitro* propagation. During the past years, micro-propagation techniques have been widely used for several plant species. Also, the plant regeneration in citrus species has been reported by various workers. Tissue culture technique could be used for propagation of citrus rootstocks and thus, the number of plants produced would not be limited by their seed supply, rather more uniform disease free and quality plant populations might be produced. In spite of micro-propagation of citrus genotypes reported by several workers, a very few reports of *in vitro* multiplication of citrus rootstocks Pectinifera, Troyer citrange, Cleopatra mandarin and Rough lemon are available in the literature.

The citrus industry is considered to be a major fruit industry hence it needs to be improved to cater to the diverse needs of consumers and crop breeders. Several attempts are made to improve Citrus species by using various *in vitro* techniques. Citrus varieties are propagated sexually through seeds, while most of the commercial varieties are propagated by various asexual methods (Chaudhary, 2). Genetic manipulation through conventional techniques in this genus is invariably a difficult task for plant breeders as it poses various biological limitations and large plant size that greatly hinder cultivar improvement. Micro propagation is an important asexual method that can be used for the production of virus – free roots tock plants (Roistacher *et al.,* 8). An efficient embryo culture protocol is a perquisite for clonal propagation of citrus species. Embryo culture can be used to rapidly expand the area under citrus cultivation as embryogenesis provides opport-unities of raising true to type plants.

MATERIALS AND METHODS

The study was carried out during 2009-10 in the Department of Horticulture, Khalsa College, Amritsar. The freshly extracted seeds from fruits of 5 citrus species viz. Baramasi lemon, Mosambi, Rangpur lime, *Pectinifera,* Jatti Khatti and a hybrid viz. *Carrizo*. The developing fruits were picked from the fruit trees growing in the field.

After extracting the seeds were washed with detergent and surface sterilized with 0.1 per cent HgCl2 (Mercuric chloride) for 8-10 minutes followed by 2-3 washings with sterilized distilled water. The testa of seeds was removed with the help of a needle and forceps. The embryos were removed and their size was measured with the help of a graph paper. Single embryo was inoculated in each culture tube containing 20 ml of MS (Murashige and Skoog) basal medium. All the experimental manipulations were carried out strictly under sterile conditions in a laminar flow cabinet (Klenzaids Bombay) and the cultures were maintained in air conditioned room at a temperature of 25 ± 2°C.

RESULTS AND DISCUSSION

(a) Germination in relation of *Citrus species*

The results of culturing of embryos in five citrus species and a hybrid have been divulged in Table 1. The data indicates that the germination ranged from 71.5 to 96.0 per cent when the embryos were inoculated on basal MS medium. The maximum (96.0 per cent) germination was recorded in *Citrus limon* and the minimum in *Citrus sinensis* (71.5 per cent). The cultured embryos showed the signs of germination after 3-4 days and emergence of the radicle within 5-7 days followed by unfolding of the cotyledons and elongation of the plumule. The embryo derived seedlings of *Citrus species* were normal in the growth and showed good root and shoot formation along with the appearance of leaves after 20-25 days of inoculation. The earlier findings of Ali and Mirza (1), Costa *et al.* (3) and Das *et al*. (4) also supported the present results.

Table 1: Germination percentage on basal MS medium through embryos in *Citrus species.*

S. No.	Name of *Citrus species*	No. of seeds	No. of seeds germinated	Germination/ regeneration (per cent)	Time taken for germination (days)	Ranking of *Citrus species* for germination of embryo
1.	*Citrus limon*	178	171	96.0	5-6	1
2.	*Citrus sinensis*	196	140	71.5	10-12	6
3.	*Citrus jambhiri*	106	97	91.5	6-8	2
4.	*Citrus limonia*	85	69	81.2	7-9	5
5.	*Citrus pectinifera*	96	80	83.3	5-8	4
6.	*Poncirus trifoliata* × *Citrus sinensis*	50	43	86.0	5-6	3

Table 2: Germination in relation to embryo size.

S. No	Citrus species	Embryo size (mm)	No. of embryos inoculated	No. of embryos germinated	Germination (%)
1	Citrus limon	3.0-5.0	17	12	70.5
		5.1-7.0	22	19	86.3
		7.1-8-0	23	22	95.6
		8.1-9.0	113	113	100.0
2	Citrus sinensis	3.0-5.0	15	4	26.0
		5.1-7.0	35	20	57.2
		7.1-8.0	60	49	81.6
		8.1-10.0	80	67	83.7
3	Citrus jambhiri	3.0-5.0	9	4	44.4
		5.1-7.0	18	16	88.8
		7.1-8.0	19	17	89.5
		8.1-9.0	60	60	100.0
4	Citrus limonia	3.0-4.0	7	2	28.5
		4.1-5.0	10	4	40.0
		5.1-6.0	11	8	72.7
		6.1-7.0	57	54	94.7
5	*Citrus pectinifera*	3.0-4.0	9	3	33.3
		4.1-5.0	12	8	66.6
		5.1-6.0	15	12	80.0
		6.1-6.5	60	57	95.0
6	*Carrizo*	4.0-5.0	5	2	40.0
		5.1-7.0	10	8	80.0
		7.1-8.0	10	8	80.0
		8.1-11.0	25	25	100.0

(b) Germination in relation to embryo size

Embryos of different sizes (<3 mm to 11 mm), cultured on MS basal medium showed great variation in germination ranging from 26.0 to 100.0 per cent in the cultivars selected (Table 2). The regenerated plants were normal in growth alongwith the formation of roots. The embryos ranging form 5 mm to 7 mm showed 94.7 per cent germination. The highest germination (100 per cent) was registered in embryos measuring from 8mm to 11 mm in case of *Citrus limon, Citrus jambhiri* and *Carrizo* while the embryos ranging from 5 mm to 6.5 mm in case of *Citrus pectinifera* showed 95 per cent germination. Plants produced were healthy and vigorous which were used for further experimental studies. It was noted that the embryos ranging form 5 mm to 7 mm produced 2-3 seedlings while 4 mm to 6 mm sized embryos only generated secondary embryoids in *Citrus pectinifera.*

The germination was high in all the species (71.5 per cent to 96.0 per cent) when embryos were cultured on basal MS medium. *Citrus sinensis* showed lesser germination as compared to the other species. Such genotypic differences in germination of seedlings from mature embryos have also been reported in different species of *Citrus* by Dubey and Rishi (5). The embryos showing less germination may be due to some developmental abnormalities of the embryos. In another experiment, embryos of different size ranging from less than 3 mm to 11mm were cultured. Embryos larger than 8 mm showed 100 per cent germination in *Citrus limon* and in *Carrizo* orange. High germination per cent for large sized embryos may be due to their capacity to produce hormones in sufficient quantity that promoted embryo development. The earlier findings revealed that the embryos smaller than 2 mm did not showed any rooting whereas 1-2 embryos had poor rooting. The experimental study revealed that germination was directly related to the embryo size, larger the embryos, higher the germination. Similar results have been reported in 'Morton' (Katyal, 7). In the present investigation embryo smaller than 2 mm lacked germination possibly due to the fact that the excised embryos were from mature fruit. The results of the present investigation on embryo culture show that larger the embryo size, higher the germination. Apart from this genotypic differences also influenced embryo germination. Seedlings derived from embryos smaller than 2 mm lacked rooting.

There is a need to culture immature embryos at different stages of their development so as to work out the minimum size of the embryos having reasonable capability to develop into seedlings for producing viable inter-specific and inter-generic hybrids.

REFERENCES

1. Ali, S. and Mirza, B. (2006). Micropropagation of rough lemon (*Citrus jambhiri* Lush): Effect of explant type and hormone concentration. *Acta Bot. Croat.* **65**(2):137-146.
2. Chaudhary, M.I. (1994). Fruit Crops. In: Malik M.N. (ed.), *Horticulture*. National Book Foundation, Islamabad, 422.
3. Costa, M.G.C., Otoni, W.C. and Moor, G.A. (2002). An evaluation of factors affecting the efficiency of *Agrobacterium* mediated transformation of *Citrus paradisi* (Macf.) and production of transgenic plants containing carotenoid biosynthetic genes. *Plant Cell Rep*., **21**:365-373
4. Das, A., Paul, A.K. and Chaudhuri, S. (2000). Micropropagation of sweet orange (*Citrus sinensis* Osbeck) for the development of nucellar seedlings. *Indian J. Exp. Biol.,* **38**: 269-72.
5. Dubey, K.C. and Rishi, N. (1976). Studies on nucellar embryos of some cultivars of *Citrus species*. *Hort. Res.,* **15**(2): 49-52.
6. Karwa, A.S. and Chikhale, N.J. (2002). Micropropagation studies in *Citrus reticulata* Blanco of Amravati Region. *Amravati Univ. Res. Bull.,* **1**(1): 27-29.
7. Katyal, S.L. (1949). Studies on seed formation, embryo development and pollen germination in Morton citrange. *Indian J. Hort.* **16**(2): 25-30.
8. Roistacher, C.N., Navarro, L., Murashige, T. (1976). Recovery of citrus selections free of several viruses, exocortis viroid and Spiroplasma citri by shoot tip grafting *in vitro*. *Proc. 7. Conf. Int. Organization Citrus Virol, IOCV, Riverside,* 186-193.

HortFlora Research Spectrum, 1(2): 131-134 (2012) ISSN : 2250-2823

EFFECTS OF DRIP IRRIGATION AND POLYTHENE MULCH ON PRODUCTIVITY AND QUALITY OF STRAWBERRY (*Fragaria ananassa*)

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ABSTRACT: A field trial was conducted under farmer's participatory research project at farmers' field in the Bhojpur district of Bihar on clay loam soil to improve strawberry (*Fragaria ananassa*) productivity and quality through drip irrigation and polythene mulch and to enhance water use efficiency through pressurized irrigation coupled with use of black polythene mulch along with surface irrigation. Drip irrigation with polythene mulch gave significantly highest yield (50.10 q ha^{-1}) as compared to surface irrigation in an unmulched condition (40.15 q ha^{-1}) however, the yield under paddy straw (45.90 q ha^{-1}) and unmulched (42.07 q ha^{-1}) was next in order to drip with polythene mulch but were significantly at par among themselves. When calculated the percentage increase the drip with polythene mulch gave 25 per cent higher yield than surface with unmulched condition. Similarly, the water use efficiency (WUE) was highest in drip irrigation with polythene mulch (7.7 kg ha^{-1} mm^{-1}) as compared to surface irrigation (5.1 kg ha^{-1} mm^{-1}). The fruit yield of strawberry under drip irrigation was found to be 46.07 q ha^{-1} compared to 40.15 q ha^{-1} under surface irrigation. Moreover, polythene mulch plus drip irrigation further raised the yields. Fruit weight increased significantly while other analyzed quality characteristics did not differ significantly among treatments. Drip irrigation besides giving a saving of 50-55 % irrigation water resulted in 20-40 % higher yield of crops studied.

Keywords: *Drip irrigation, mulch, black polythene, WUE, fruit yield, fruit quality.*

Micro (Drip) irrigation system has proved its superiority over other conventional methods of irrigation, especially in horticultural crops (fruit crop), owing to precise and direct application of water in the root zone. A considerable savings in water and fertilizer use besides increased growth, development and yield of vegetable crops under drip irrigation have been reported (Bhella, 2; Malik *et al.*, 3). The use of black polythene mulch in fruit and vegetable crops has been reported to control the weed incidence, reduce nutrient losses and to improve the hydro-thermal regime of soil (Ashworth and Harrison, 1; Raina *et al.,* 5). Strawberry, being a shallow rooted plant requires more frequent but less amount of water for each irrigation, which can be accomplished more efficiently through drip system. The consequences of drip irrigation in this crop have not yet been completely established. The present studies were, therefore, undertaken to evaluate the effect of drip irrigation alone and in conjunction with polythene mulch compared to surface irrigation on water use efficiency, yield and quality of strawberry. Considering the additional cost of inputs and the selling price of the quality produce, the polythene mulch with drip irrigation may be recommended to the more progressive farmers for cultivation of strawberry in Bihar, however grass mulch can also be used to make technology more resource crunched farmer friendly intervention for cultivation of strawberry especially under Bihar socio-economic condition. The strawberry is the most profitable fruit crop in the shortest possible time as compared to other fruits.

By spending 10 lakhs ha^{-1} one can get a receipt of Rs. 20 lakh ha^{-1} in strawberry. It can be grown on any type of soil, poor sand to heavy clay provided proper moisture organic matter and drainage is present. It is a short day plant (about 10 days of less than 8 hours sunshine for initiation of flowering). In winter, the plants don't make any growth and remain dormant. In spring, when days become longer and temperature rises, the plants resume growth and begin flowering.

Received : 1.3.2012 *Accepted : 16.3.2012*

MATERIALS AND METHODS

Field trial was conducted under farmer's participatory research project in the farmers' field in the Bhojpur district of Bihar, on clay loam soil having pH 6.43, E.C. 0.13 dSm^{-1}, organic carbon 0.86 %, The available N, P and K were 203.06; 551.6 and 14.73 kg ha^{-1}, respectively with twin objective : (1) to improve strawberry (*Fragaria ananassa*) productivity and quality through drip irrigation and polythene mulch and (2) to enhance water productivity through pressurized irrigation coupled with use of black polythene mulch along with surface irrigation. Treatments comprised of two irrigation schedules (drip and surface irrigation) and three mulches viz., black polythene (25 micron), paddy straw (4.0 t ha^{-1}) and unmulched conditions. These treatments were tested in 2 m x 2 m raised bed plots (each plots consisted of 10 beds) arranged in randomized block design (RBD) with six replications. Treatment denoted as under *i.e.* T_1 = Surface irrigation (S_I) + unmulch; T_2 = S_I + paddy straw; T_3 = S_I + Black polythene mulch; T_4 = Drip irrigation (D_I) + unmulch; T_5 = D_I + paddy straw; T_6 = D_I + Black polythene mulch (BP).

RESULTS AND DISCUSSION

Effects of drip irrigation and polythene mulch on strawberry runner production :

Drip irrigation without mulch and with paddy straw mulch significantly increased the runner production. However, with drip plus BP mulch it was reduced significantly compared with surface irrigation (Table 1). Since the black polythene could not provide an anchor for the roots of the new runners, this impeded their production. It is therefore, suggested that after crop harvest, black polythene be removed to provide favourable soil environment for higher runner production.

Effects of drip irrigation and polythene mulch on strawberry fruit yield:

The data on strawberry fruit (Table 1) indicate that the drip irrigation without mulch increased the fruit yield by about 21.0 and 9.0 % over surface irrigation. The corresponding values with paddy straw mulch were 15 and 10 %. Maximum fruit yield was observed under drip with BP mulch and increase in yield of 22 %, over the surface irrigation plus BP mulch (Table 1). These results are in accordance with the findings of Rolbiecki *et al.* (6) who observed higher Strawberry yield under drip compared to surface irrigation. Both the mulches were found to be effective in increasing the yield over un-mulch treatment. Surface irrigation with paddy straw and BP increased the yield by about 18 and 37 % respectively, over the un-mulch plots (Table 1). The higher yields observed under different mulches may be explained in the light of results reported by Raina *et al.* (5). They observed that the paddy straw and polythene mulches are effective in altering the soil hydrothermal regimes, thus providing a favourable soil environment for enhanced root/shoot growth and the nutrient uptake by strawberry. Higher yield under mulch treatments may be ascribed to its favourable effects on weed control.

Drip irrigation with polythene mulch gave significantly highest yield (50.10 q ha^{-1}) as compared to surface irrigation in an unmulched condition (40.15 q ha^{-1}) (5.01 t ha^{-1}), however, the yield under paddy straw (45.90 q ha^{-1}) and unmulched (42.07 q ha^{-1}) was next in order to drip with polythene mulch but were significantly at par among themselves. When calculated the percentage increase the drip with polythene mulch gave 25 per cent higher yield than surface with unmulched condition. The use of black polythene mulch in strawberry has been reported to control the weed incidence, reduce nutrient losses and improves the hydro-thermal regime of soil. Strawberry, being a shallow rooted plant requires more frequent but less amount of water for each irrigation, which can be accomplished more efficiently through drip system. Polythene especially black polythene mulch contributed significantly to control leaf spot disease. Higher yield under mulch treatments may be ascribed to its favourable effects on weed

Table 1: Effect of irrigation and mulch treatments on fruit and dry matter yield and quality characteristics of strawberry fruits.

Treatments	Berry weight (g)	Fruit yield (kg ha^{-1})	Runner production / plant	TSS (%)	Acidity (%)	TSS/Acid ratio
T_1	5.6	4015	11.3	7.17	0.82	8.79
T^2	6.8	4154	07.7	6.74	0.71	9.28
T_3	6.3	4364	7.75	6.99	0.78	9.01
T_4	6.1	4207	16.6	7.06	0.80	8.78
T_5	8.4	4590	11.5	6.66	0.70	9.50
T_6	7.0	5010	12.3	6.86	0.71	9.37
C.D. (P = 0.05)	0.3	56	1.2	0.27	0.08	0.87

Table 2: Effect of irrigation and mulch treatments on strawberry water use efficiency.

Treatments	Water Use Efficiency (kg $ha^{-1}mm^{-1}$)		
	Ist year	IInd year	Pooled
T_1	3.8	3.6	3.7
T_2	4.9	4.6	4.7
T_3	6.3	5.9	6.1
T_4	6.2	6.7	6.5
T_5	7.7	7.9	7.8
T_6	10.5	10.3	10.4
C.D. (P = 0.05)	1.2	1.7	1.5

control. Quality fruits were harvested due to infestation free crop. Results show that there was 85 per cent weed control was achieved under black polythene mulch as compare to weedy check plot. Mulching could save precious labourer as it requires frequent weeding @ 15 days interval during the growing season. Considering the additional cost of inputs and the selling price of the quality produce, the polythene mulch with drip irrigation may be recommended to the more progressive farmers for cultivation of strawberry in Bihar. However, grass mulch can also be used to make technology more resource crunched farmer friendly intervention for cultivation of strawberry especially under Bihar socio-economic condition. The corresponding figures for water savings and increase in yield for strawberry were 51 and 19%, respectively.

The results further document that irrigation requirement of Strawberry can be met effectively by operating the drip system having discharge rate of 4 lit h^{-1} biweekly during the growing season.

Effects of drip irrigation and polythene mulch on production and fruit quality:

Drip irrigation without mulch and with paddy straw mulch significantly increased the runner production. However, with drip plus black polythene mulch it was reduced significantly compared with surface irrigation (Table 1). Since the black polythene could not provide an anchor for the roots of the new runners, this impeded their production. It is therefore, suggested that after crop

harvest, black polythene be removed to provide favourable soil environment for higher runner production.

Maximum fruit weight (8.4 g / fruit) was recorded under drip plus paddy straw treatment. It may be attributed to the fact that under paddy straw treatment, number of flowers and fruits was less than those under BP mulch (Raina *et. al.* 5). Drip plus paddy straw produced fruit with higher TSS / acidity ratio. Comparable results regarding total soluble solids, sugar contents and titrable acidity were obtained by Mishra (4). In strawberry, drip irrigation without mulch increased the fruit weight by about 6 % over surface irrigation and when coupled with paddy straw and BP, the corresponding increase was 32 and 16%, respectively (Table 1).

Effects of drip irrigation and polythene mulch on water use efficiency (WUE):

The corresponding values for drip plus paddy straw and surface irrigation plus paddy straw were 6.8 and 4.7 kg ha^{-1} mm^{-1} and these values for drip plus polythene mulch and polythene mulch plus surface irrigation were 7.7 and 5.1 kg ha^{-1} mm^{-1} respectively. Highest water use efficiency of 7.7 kg ha^{-1} mm^{-1} was observed under drip plus black polythene mulch (Table 2). Drip system delivers water directly into the root zone without wetting the entire area, thus, probably resulted in higher water use efficiency compared to surface irrigation. Drip irrigation, both with and without polythene mulch registered higher water use efficiency (WUE) as compared to surface irrigation. Averaged overall level of irrigation, drip irrigation, without mulch gave water use efficiency of 5.5 (kg ha^{-1} mm^{-1}) against 3.7 (kg ha^{-1} mm^{-1}) under surface irrigation (Table 2).

CONCLUSION

It is concluded that, drip system is very effective and efficient method of irrigation for raising strawberry crop, especially on light texture soils and in water scarce areas. The corresponding figures for water savings and increase in yield for strawberry were 51 and 19%, respectively. The results further document that irrigation requirement of Strawberry can be met effectively by operating the drip system having discharge rate of 4 lit h^{-1} biweekly during the growing season.

REFERENCES

1. Ashworth, S. and Harrison, H. (1983). Evaluation of mulches for use in the home garden. *Hort. Sci.,* **18**:180-182.
2. Bhella, H.S. (1998). Tomato response to trickle irrigation and black polythene mulch. *J. Am. Soc. Hort. Sci.,* **13** (4): 543-546.
3. Malik, R. S., Kumar, K. and Bhandari, A.R. (1994). Effect of urea application through drip irrigation system on nitrate distribution in loamy sand and pea yield. *J. Indian Soc. Soil Sci.*, **42** (2): 6-10.
4. Mishra, S. K. (1982). Standardization of the agro-techniques of strawberry (*Fragaria ananassa, Duch. cv. Tioga*). *Ph.D. Thesis*, HPKV, Palampur.
5. Raina, J.N. Thakur, B.C. and Sephia R. (2004). Effect of mulches on soil Hydrothermal regimes, root growth, yield and quality of strawberry. *Ann. Pl. Soil Res.*, **12:** 6-30.
6. Rolbiecki, S., Rzekanowski, C., Scheer, D., Lieten, F. and Dijkstra, J. (1997). Influence of sprinkler and drip irrigation on the growth and yield of strawberry grown on sandy soils. *Acta Hort.,* **43**(9): 669-672.

HortFlora Research Spectrum, 1(2): 135-138 (2012) ISSN : 2250-2823

INFLUENCE OF PACLOBUTRAZOL AND ETHEPHON ON FRUIT QUALITY OF 'ALLAHABAD SAFEDA' GUAVA

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ABSTRACT: Investigation on 4-year old plants of guava cv. Allahabad Safeda was conducted to find out the influence of gibberellin-inhibitor paclobutrazol (PBZ), [(2RS, 3RS)-1-(4-chlorophenyl)-4,4-dimethyl-2-(1,2,4 triazol-1-yl)pentan-3-ol] and ripening promoter ethephon [(2-chloroethyl) phosphonic acid], on fruit quality. Treatments in the form of foliar application were applied repeatedly during March 2007 and 2008 at 500 and 1000 ppm of each chemical on plants at 6x5m spacing. Fruit size and weight was recorded higher in all treated plants during both rainy and winter seasons as compared to untreated plants. Number of seed was counted highest in fruits obtained from control plants during both seasons. Pulp proportion was not affected significantly with treatments. The palatability rating and TSS of fruits during both rainy and winter season were recorded higher and acidity was recorded lower in treated plants as compared to untreated plants. Highest vitamin C content was noted in fruits obtained from ethephon 1000 ppm treated plants during rainy season and ethephon 500 ppm during winter season. Although, PBZ 500 ppm was found to increase the fruit size and weight particularly during rainy season but ethephon 500 ppm treated plants provided fruits with best eating quality.

Keywords: *Guava, paclobutrazol, ethephon, physical and chemical characters.*

Guava (*Psidium guajava* L.) is very important tropical as well as subtropical fruit crop of the world and is a potential crop of India. Due to its hardy, prolific bearing nutritive, highly remunerative nature, it surpasses many other fruit crops. Moreover this fruit can be grown satisfactorily even in adverse soil and climatic conditions. Although, the area and production of guava increased in last decade, but there is no significant increase in productivity. Presently the productivity of guava is much below the productive potential, due to lack of suitable planting system, planting of less number of trees per unit area, lack of canopy management practice etc. Therefore, the main emphasis should be laid on management of tree canopy in such a way that leads to accommodation of higher number of plans as to get higher production of good quality fruits per unit area. As guava plants exhibits extensive vegetative growth annually and are highly responsive to canopy modification, there is always a scope to increase production and income from a unit land area by using various cultural techniques and application of certain chemicals which restricts the vegetative growth without affecting the fruit quality. Therefore, the present investigations are aimed to study the effect of growth retardants on physico-chemical properties of guava fruits.

MATERIALS AND METHODS

Investigation on 4-year plants of guava cv. Allahabad Safeda was conducted to examine the effect Paclobutrazol (PBZ) and Ethephon on fruit quality. Treatments in the form of foliar application were applied repeatedly during March 2007 and 2008 at 500 and 1000 ppm of each chemical on plants at 6x5m spacing. Physical characters of both rainy and winter season crops were recorded in July-August and November-December, respectively during the year 2007 and 2008. The observations on physical characters of fruits were noted in terms of fruit size, fruit weight, seed

Received : 12.1.2012 *Accepted : 6.2.2012*

number per fruit and pulp proportion was recorded. The quality characters of both rainy and winter season fruits were recorded in July-August and November-December, respectively during both the years. The data on quality characters of fruits were determined in terms of palatability rating, total soluble solids, acidity, pulp content and vitamin C.

Palatability rating in terms of general appearance, taste and flavour were recorded by panel of five judges on the basis of Hedonic scale 1-9 as follow.

Rating of fruits

Extremely desirable	9 marks,
Very much desirable	8 marks
Moderately desirable	7 marks,
Slightly desirable	6 marks
Neither like nor dislike	5 marks,
Slightly dislike	4 marks
Moderately dislike	3 marks,
Very much dislike	2 marks
Extremely dislike	1 mark

Total soluble solids content of juice was determined with the help of Bausch and Lomb hand refractometer in terms of degree Brix. The values of total soluble solids were corrected at 20°C with the help of temperature correction chart (AOAC, 1). Similarly, acidity and Vitamin C was determined according to the method of AOAC (1). Colour of the fruits was recorded with the help of Horticultural Colour Charts (Wilson, 6).

RESULTS AND DISCUSSION

Physical characteristics of guava fruits

The fruit size was significantly affected by different growth regulator treatments in both the seasons. During rainy season, the mean fruit size under all treatments was found increased compared to control. Maximum fruit length (4.98 cm) in PBZ 500 ppm and breadth (5.12 cm) in PBZ 1000 ppm was observed during rainy season (Table 1) and minimum fruit size (4.46 cm length and 4.56 cm breadth) was obtained in control plants. In winter season (Table 2), the maximum fruit length and breadth was noted with PBZ 1000 ppm (6.65 cm and 6.43cm) and minimum with untreated (6.29 cm and 6.23 cm) plants.

Fruit weight was also influenced by the application of growth regulators in both the seasons. During rainy season maximum fruit weight (76.33g) was observed with PBZ 500 ppm treatment and minimum fruit weight (62.33 g) was observed in untreated plants. However, in winter season fruits, plants sprayed with PBZ 1000 ppm exhibited highest (158.5 g) fruit weight and control plants gave lowest (128.4 g) fruit weight. Increase in fruit size and weight may be attributed to the increased supply of nutrient and photosynthates to the developing fruits at the expense of restricted vegetative growth.

PBZ and ethephon treatments also influenced the seed setting in guava fruits. The least number of seeds i.e. 212 was extracted from the rainy season fruits picked from the plants sprayed with the ethephon 1000 ppm and maximum seeds (257) were observed in fruit obtained from the plants kept as control. In a similar way maximum number of seeds (324) was extracted from control plants and minimum (266) in PBZ 1000 ppm treated plants during winter season. Reduction in seed number in fruits treated with chemicals may be due to adverse effect on pollen germination on the stigma. Treatments of growth regulators had non-significant effect on pulp proportion in both rainy and winter season crops.

Chemical characteristics of guava fruits

The palatability of fruits was judged highest in rainy season (Table 3) guava plants applied with ethephon 1000 ppm (6.42) and minimum (6.28) in control plants. In winter season (Table 4) ethephon 1000 ppm also makes the fruits more palatable with PLR of 8.11 followed by 8.09 in ethephon 500 ppm. Untreated plants provided fruits with least palatability rating of 7.95. The results obtained are in line with those of Yadav *et al.* (7), who obtained

Table 1 : Effect of PBZ and ethephon on physical characteristics of rainy season guava fruits.

Treatments (ppm)	Fruit length(cm)	Fruit breadth (cm)	Fruit weight (g)	Seed numbers	Pulp content (%)
P-500	4.98	5.01	76.33	232	89
P-1000	4.86	5.12	73.67	242	89.1
E-500	4.72	5.10	71.91	226	88.9
E-1000	4.86	4.93	70.79	212	88.6
Control	4.46	4.56	62.33	257	88.2
CD (P=0.05)	0.11	0.12	3.92	10.2	NS

Table 2 : Effect of PBZ and ethephon on physical characteristics of winter season guava fruits.

Treatments (ppm)	Fruit length(cm)	Fruit breadth (cm)	Fruit weight (g)	Seed numbers	Pulp content (%)
P-500	6.58	6.30	153.1	311	93.1
P-1000	6.65	6.43	158.5	266	94.1
E-500	6.47	6.35	154.3	294	94.0
E-1000	6.35	6.41	145.5	301	94.3
Control	6.29	6.23	128.4	324	93.9
CD (P=0.05)	0.11	0.13	10.4	12.1	NS

Table 3 : Effect of PBZ and ethephon on chemical characteristics of rainy season guava fruits.

Treatments (ppm)	Palatability rating (out of 9)	Total soluble solids (%)	Acidity (%)	Vitamin C (mg/100g pulp)	Fruit colour
P-500	6.36	9.34	0.17	131.94	YGG 144 D
P-1000	6.33	9.49	0.169	135.85	GG 142 B
E-500	6.37	9.5	0.174	138.07	Y 144 C
E-1000	6.42	9.6	0.172	140.04	Y 12C
Control	6.28	9.33	0.176	132.94	GG 142 B
CD (P=0.05)	0.11	0.14	0.04	5.22	-

Table 4 : Effect of PBZ and ethephon on chemical characteristics of winter season guava fruits.

Treatments (ppm)	Palatability rating (out of 9)	Total soluble solids (%)	Acidity (%)	Vitamin C (mg/100g pulp)	Fruit colour
P-500	8.03	10.25	0.211	163.1	GG 142 B
P-1000	8.04	10.43	0.202	164.3	YGG 149 A
E-500	8.09	10.43	0.214	168.2	YG 150C
E-1000	8.11	10.7	0.2	166.4	YGG 154 B
Control	7.95	10.2	0.23	163.83	GG 142 B
CD (P=0.05)	0.04	0.14	0.01	2.98	-

maximum palatability rating of guava fruits with ethrel 1000 ppm (8.1 out of 10). In a similar way the palatability was observed maximum under ethephon treatment (1000 ppm) when treatments of ethephon and PBZ @500 and 1000ppm each were given to guava cv. Allahabad Safeda (Singh and Bal, 3).

In rainy season, the total soluble solids were found maximum i.e.9.60 % with ethephon 1000 ppm followed by 9.50 % in ethephon 500 ppm treated plants. The fruits taken from control plants exhibits lowest (9.33 %) TSS content. Winter season fruits of guava gave highest TSS i.e.10.70 % in ethephon 1000 ppm treated plants. Fruits taken from untreated plants gave minimum TSS of 10.20 %. Acid content in fruits was recorded highest in plants kept as control in both rainy (0.176 %) and winter (0.23 %) season crops. The plants sprayed with PBZ 1000 ppm in rainy season and ethephon 1000 ppm in winter season contained fruis with minimum acid content of 0.169 and 0.2 %, respectively. The results obtained are in similar lines with Singh *et al.* (2) and Yadav *et al.* (7) who reported no significant effect of ethrel on the acidity of guava fruits. The results are in line with that of Suleman et al (5) who sprayed ethephon during May and reported that the acidity was significantly reduced by higher dose of ethephon during both rainy and winter season fruits.

Ethephon treatments increased the vitamin C content in rainy as well as winter season fruits. Maximum content of vitamin C was noticed in rainy season guava fruit (140.04 mg/ 100 g fruit pulp) obtained from trees treated with ethephon 1000 ppm and 168.2 mg/ 100 g fruit pulp in ethephon 500 ppm treatment in winter season. The minimum vitamin C content (131.94 mg/100g) was estimated in rainy season and 163.1 mg/ 100 g fruit pulp in winter season in plants treated with PBZ 500 ppm application. The observations on estimation of vitamin C are not coincide with the results of Singh (4) who recorded the higher vitamin C content in fruits of rainy season guava cv. Sardar received from plants sprayed with PBZ 500ppm compared to other treatments.

The colour of rainy season fruits (Table 3) was found to be improved with both 500 and 1000 ppm ethephon treatments i.e. yellow green (Y 144 C) and yellow (Y 12 C), respectively. Fruit colour of PBZ treated plants was less developed compared to ethephon. In PBZ treatments, the colour of the fruits ranged from light yellow green (YGG 144 D) to light green (YGG 142 B). The least colour development of the fruits i.e. light green (GG 142 B) was noted in the fruits in untreated plants under paclobutrazol treatment. Similarly in winter season (Table 4), both the ethephon treatments showed better colour development of fruits i.e. yellow to yellow green as compared to paclobutrazol and control. Fruit colour improvement in ethephon treatments may be due to ripening enhancing properties of ethephon.

REFERENCES

1. A.O.A.C. (2000). *Official Methods of Analysis*. 17th Edn. Association of Official Analytical Chemists. Washington D.C., USA.
2. Singh, Bikramjit, Singh Sukhdev and Sandhu, Savreet (2012). Effect of growth retardants and vegetative growth, flowering and fruiting of litchi cv. Calcuttia. *HortFlora Res. Spectrum*, **1**(1) : 29-33.
3. Singh, H. J. and Bal, J. S. (2006). Effect of pruning and growth regulators on physico-chemical characters of guava during rainy season planted at different spacing. *Int. J Agric. Sci.*, **2:** 533-537.
4. Singh, R. (2006). High density planting studies in Sardar guava (*Psidium guajava* L.) *M.Sc Thesis,* PAU,Ludhiana.
5. Suleman, M., Sharma J.R., Kumar, R., Gupta, R. B. and Singh, S. (2006). Effect of different chemicals on cropping pattern, and quality of guava cv. Sardar. *Haryana J. Hortic. Sci.*, **35**: 226-227.
6. Wilson, R. F. (1938). *Horticultural Colour Chart.* Wilson Colours Ltd. in Collaboration with the Royal Horticultural Society of British Colour Council, London.
7. Yadav, S., Bhatia, S.K., Godara, R.K and Rana, G.S. (2001). Effect of growth regulators on the yield and quality of winter season guava cv. L-49. *Haryana J. Hortic. Sci*. **30:** 1-2.

HortFlora Research Spectrum, 1(2): 139-144 (2012) ISSN : 2250-2823

GENETIC VARIABILITY, HERITABILITY, GENETIC ADVANCE, CORRELATION AND PATH ANALYSIS IN OKRA

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ABSTRACT : A field experiment was conducted with twenty diverse genotypes of Okra (Pusa Makhamali, VRO-6, VRO-5, Selection-10, IIVR-10, HRB-10, IIVR-11, Perkins Long Green,VRO-4, HRB-9-2, Parbhani Kranti, RS-410, Punjab-7, DOV-91-4, D-1-87-1, EMS-8-1,Bhindi Vaphy, 315, and BO-2) in randomized block design with three replications. Analysed data revealed that among all the genotypes, Pusa Makhamali, Perkins Long Green, Parbhani Kranti, VRO-6, VRO-5 and Selection-10 gave promising results.

Keywords: *Okra, genetic variability, heritability, genetic advance, path analysis.*

Okra [*Abelmoschus esculentus* (L.) Moench] belongs to family Malvaceae with 2n =130 chromosomes. It is one of the most important vegetable crops, which is grown throughout the tropical and subtropical parts of the world. Being a day neutral plant, it is cultivated in every season in one or other parts of the country. Being a multipurpose, okra is valued for its tender delicious fruits. Its dry seed are a rich source of iodine, carbohydrate, protein, oil and vegetable curd. Seeds are also used as coffee additive or substitute. Its dry seeds contain 13-22% edible and 20-24% crude protein (Thamburaj and Singh, 9), foliage can be used for biomass and dried stem as the source of paper pulp or fuel. Its roots are used to clean sugarcane juice to make jaggery. Okra is praised for its medicinal values, as its fruits are useful in genito-urinary disorders, spermatorrhoea and chronic dysentery. Okra is often cross-pollinated where the natural cross-pollination occurs from 8.75 to 9.61%. Okra is highly susceptible to frost and requires warm climate for fruit production. The improvement in genetic make up *i.e.,* growing habit of the plant increases the harvest index and improvement in resistance to insect-pest and diseases ultimately increase the yield. There are great prospects and possibilities for the further increase in productivity and production of okra. Increase in genetic yield potential gives a boost to okra production. Some biometrical techniques like variability, correlation and path analysis provide relative contribution of various yield related traits. Genotypic and phenotypic coefficients of variance suck out the association between yield and yield contributing traits in okra. If the association is positive and significant, simultaneous important and association is possible and significant. As the correlation measures the mutual relationship between different traits of a plant, it helps to determine the best yield contributing traits. Path analysis deals with a close system of variables that are linearly related. It specifies the causes and generally measures their relative importance. Path analysis split the correlation coefficient in to the measures of direct and indirect effect and determines direct and indirect contribution of various characters towards the yield.

Received : 23.12.2011 Revised : 18.2.2012 Accepted : 20.3.2012

MATERIALS AND METHODS

The experimental material included 20 diverse genotypes viz. (Pusa Makhamali, VRO-6, VRO-5, Selection-10, IIVR-10, HRB-10, IIVR-11, Perkins Long Green, VRO-4, HRB-9-2, Parbhani Kranti, RS-410, Punjab-7, DOV-91-4, D-1-87-1, EMS-8-1, Bhindi Vaphy, 315, and BO-2) and were sown during rainy season of the year 2005-06 in randomized block design with there replications at Vegetable Research Farm, Institute of Agricultural Sciences, BHU, Varanasi (U.P.). Row -to -row and plant-to-plant spacings were maintained 60 cm and 30 cm, respectively. All the agronomic packages of practices were adopted to grow a healthy crop in each replication. Randomly 5 plants in each

genotype were marked for observation. Observations were recorded in 12 characters viz, plant height (cm), no. of branches /plant, no. of flowers/ plant, no. of fruits/ plant, no. of fruits/ branch, length of fruit (cm), weight of fruit/ plant(g), diameter of fruit (cm) and yield/plant. The recorded data were analyzed as suggested by Panse and Sukhatme (8) for analysis of variance. The genotypic and phenotypic coefficient of variance was calculated as per the formula suggested by Burton (3). Johnson and Comstock (5) for heritability and genetic advance, Al – Jibouri *et al.,* (1) for correlation coefficient and Deway and Lu (4) for path coefficient.

RESULTS AND DISCUSSION

The mean sum of square was highly significant for all traits, indicating the presence of wide variability in the present genotypes of okra (Table 1). Yield /plant (g) showed a widest range (307.41 – 702.67), the minimum and maximum yield /plant at edible stage was recorded in genotypes Bhindi Vaphy and Pusa Makhamali, respectively with a mean value 401.48. Maximum plant height (cm) was recorded in Pusa Makhamali, (114.71) while minimum in Punjab selection (72.17), with a mean value 90.15. Days to flower appearance ranged from 45.32 to 65.32 (Parbhani Kranti and IIVR-10). Number of leaves/ plant and no. of flowers/plant also registered considerable variability, which ranged from 40.39 to (BO-2) to 77.55 (Pusa Makhamali) and 29.90 (BO-2) to 77.67 (Pusa Makhamali) maximum no. of fruits/plant was recorded in VRO-6 and minimum in EMS-8-1, maximum diameter of fruits was recorded in Pusa Makhamali (10.53) and minimum in BO-2 with a mean 8.60. Maximum length of fruits was recorded in Pusa Makhamali (9.60 cm), while minimum in BO-2 (6.19 cm) with a mean value 8.25. The maximum no. of fruits/ branch (9.10) was recorded in VRO-6 and minimum in Larm (5.93). The maximum no. of branches/plant was recorded in VRO-6 and minimum in Perkins Long Green, respectively. The maximum weight of fruit was recorded in Pusa Makhamali and minimum in Bhindi Vaphy.

In general, the phenotypic variance and phenotypic coefficient of variance were higher than their respective genotypic variance and genotypic coefficient of variance for all the traits (Table 2), indicating considerable effects of environment on their expression. In the present investigation, genotypes were found to possess a high to moderate phenotypic variance for various characters as revealed by PCV. Phenotypic coefficient of variance varied from 7.53 (weight of fruits) to 25.63 (no. of fruits/plant). The PCV expressed in form of percentage were high for no. of fruits/plant followed by yield/plant, no. of flowers/plant, no. of branches/plant, no. of leaves/plant, length of fruit, no. of fruits/branch, diameter of fruit (mm) and plant height (cm).

As the estimate of phenotypic variability cannot differentiate between the effect of genetic and environmental effects, so the study of genetic variability is effective in partioning out the real genetical differences. Higher the GCV, more the chances of improvement in that characters. In the present experiment, GCV were comparatively high for no. of fruits/ plant followed by yield/ plant, no. of flowers/plant, no. of leaves/plant, no. of branches/plant, plant height and stem diameter. The GCV was less than the corresponding PCV, indicating the role in the expression of the traits under the observation.

The difference between GCV and PCV was more in case of no. of branches/plant followed by no. of days to flower and length of fruits. The large difference between GCV and PCV indicated that environment affects to a large extent influence the traits having high GCV possessed better potential for further gain and improvement. Burton (3) has suggested that GCV together with heritability estimates would give the best option expected for the selection. Heritability estimates were high (>90%) for plant height, no. of leaves/ plant, no. of flowers/plant, no. of fruits/plant and yield/plant. Moderate heritability (70-90%) for no. of days to flower, diameter of stem , no. of fruits/branch and

Table 1: Estimates of range, general mean, standard error of mean, PCV, GCV and C.D. value for 12 characters in Okra.

S. No.	Characters	Range		Means	Standard error of mean	PCV (%)	GCV (%)	C.D. (P=0.05)
		Min.	Max.					
1.	Plant height (cm)	72.17(PB-7)	114.77(Pusa Makhamali)	90.15	2.102	14.45	14.16	4.248
2.	No. of branches/plant	3.99(BO-2)	9.72(VRO-5)	7.21	1.046	23.15	14.83	2.113
3.	No. of days to flower	45.32(P.Kranti)	65.32(IIVR-10)	53.83	1.634	11.41	10.79	3.302
4.	Diameter of stem	1.63(PLG)	2.84(VK-06)	1.989	0.125	11.92	13.93	0.252
5.	No. of leaves of/plant	40.39(BO-2)	77.55(Pusa (Makhamali)	57.56	1.753	19.64	19.28	5.542
6.	No. of flower/plant	25.90(BO-2)	77.67(Pusa Makhamali)	56.18	1.867	23.51	23.15	3.773
7.	No. of fruits/branch	5.93(Larm-1)	9.10(VRO-6)	74.56	0.431	16.18	14.55	0.871
8.	No. of fruits/plant	22.92(Ems-8-1)	75.93(VRO-6)	53.96	1.995	25.63	25.22	4.032
9.	Length of fruit (cm)	6.19(BO-2)	9.60 (P. Makhamali)	8.265	1.094	17.71	7.12	2.210
10.	Diameter of fruit (cm)	6.96 (BO-2)	10.53(P. Makhamali)	8.601	0.433	15.74	11.15	0.875
11.	Weright of fruits (g)	1.27 (Bhindi vaphy)	1.64 (Bhindi Vaphy)	1.479	0.105	7.53	5.73	0.101
12.	Yield/plant (g)	307.41 (Bhindi Vaphy)	702.67(Pusa (Makhamali	481.48	11.349	25.52	25.18	2.726

Table 2: Estimate of phenotypic variation and genotypic variation, heritability and genetic advance for 12 characters of Okra.

S. No.	Characters	Phenotypic variation	Genotypic variation	Heritability (%)	Genetic advance	Genetic advance of mean
1.	Plant height (cm)	1.3 88	1.328	0.961	25.79	1226.92
2.	No. of branches /plant	0.945	0.373	0.411	1.41	134.79
3.	No. of days to flower	0.263	0.229	0.894	11.31	692.16
4.	Diameter of stem	0.440	0.408	0.766	0.50	399.68
5.	No. of leaves / plant	94.316	93.18	0.964	22.45	1280.66
6.	No. of flowers /plant	0.255	0.078	0.970	26.39	1413.49
7.	No. of fruits /branch	8.065	7.987	0.808	2.01	466.35
8.	No. of fruits /plant	1.385	0.866	0.969	27.60	1383.45
9.	Length of fruit (cm)	0.482	0.296	0.462	0.49	44.78
10.	Diameter of fruit (cm)	0.405	0.396	0.766	1.73	399.44
11.	Weight of fruits (g)	0.917	0.737	0.578	0.13	260.00
12.	Yield / plant (g)	227.29	226.40	0.973	246.43	2171.38

Table 3 : Estimates of phenotypic (P) and genotypic (G) correlation coefficient for different characters in Okra.

Characters		Plant height (cm)	No. of branches /plant	No. of days to flower	Dia-meter of stem	No. of leaves/ plant	No. of flowers/ plant	No. of fruits/ branch	No. of fruits/ plant	Length of fruit (cm)	Dia-meter of fruit (cm)	Weight of fruits (g)	Yield/ plant
Plant height (cm)	P		0.097	0.068	0.005	0.180	0.614**	0.510**	0.775**	0.316	0.246	0.592**	0.347
	G		0.064	0.059	0.008	0.174	0.402*	0.069	0.159	0.164	0.496*	0.006	0.141
No. of branches/plant	P			0.060	0.321	0.045	0.061	0.183	0.118	0.272	0.349	0.404*	0.276
	G			0.692**	0.162	0.003	0.525**	0.639**	0.484*	0.464*	0.326	0.508**	0.507**
No. of days to flower	P				0.008	0.054	0.624**	0.441**	0.435*	0.445*	0.525**	0.418*	0.0515*
	G				0.024	0.657**	0.0456*	0.595**	0.514**	0.439*	0.431*	0.643**	0.591**
Diameter of stem	P					0.133	0.462*	0.499*	0.047	0.089	0.161	0.045	0.389
	G					0.423*	0.419*	0.658**	0.427*	0.420*	0.220	0.520**	0.636**
No. of leaves/plant	P						0.645**	0.103	0.198	0.454*	0.212	0.453*	0.465*
	G						0.632**	0.468*	0.382	0.111	0.448*	0.446*	0.665**
No. of flowers/plant	P							0.155	0.450*	0.567**	0.493*	0.595**	0.793**
	G							0.007	0.616**	0.673**	0.263	0.456*	0.687**
No. of fruits/branch	P								0.541**	0.191	0.571**	0.470*	0.661**
	G								0.584**	0.423*	0.330	0.545**	0.511**
No. of fruits/plant	P									0.151	0.438*	0.588**	0.627**
	G									0.534**	0.300	0.484*	0.610**
Length of fruit (cm)	P										0.525**	0.478*	0.519**
	G										0.301	0.066	0.601**
Diameter of fruit (cm)	P											0.448*	0.523**
	G											0.335	0.347
Weight of fruit (g)	P												0.614**
	G												0.650**

Table 4 : Direct (diagonal) and indirect effects of different traits contributing to yield in Okra (phenotypic level)

Character	Plant height (cm)	No. of branches/plant	No. of days to flower	Diameter of stem (cm)	No. of leaves/ plant	No. of flower/ plant	No. of fruits/ branch	No. of fruits/ plant	Length of fruit (cm)	Diameter of fruit (cm)	Weight of fruits (g)	Genotypic Correlation Coefficient of Yield
Plant height (cm)	**0.295**	0.019	0.017	0.002	0.051	0.090	0.020	0.047	0.048	0.146	0.019	0.141
No. of branches/ plant	0.005	**0.077**	0.007	0.012	0.000	0.002	0.011	0.006	0.013	0.025	0.016	0.507
No. of days to flower	0.007	0.011	**0.117**	0.003	0.007	0.012	0.011	0.013	0.016	0.015	0.005	0.591
Diameter of stem (cm)	0.003	0.062	0.009	**0.074**	0.042	0.157	0.137	0.010	0.008	0.034	0.008	0.336
No. of leaves/ plant	0.037	0.001	0.012	0.026	**0.055**	0.133	0.014	0.038	0.023	0.094	0.073	0.165
No. of flower/ plant	0.023	0.052	0.008	0.030	0.047	**0.328**	0.000	0.150	0.005	0.019	0.012	0.687
No. of fruits/ branch	0.004	0.008	0.005	0.200	0.004	0.000	**0.210**	0.270	0.007	0.018	0.019	0.511
No. of fruits/plant	0.115	0.061	0.083	0.019	0.132	0.012	0.351	**0.726**	0.025	0.218	0.133	0.610
Length of fruit (cm)	0.035	0.035	0.029	0.004	0.024	0.016	0.026	0.007	**0.212**	0.264	0.014	0.601
Diameter of fruit (cm)	0.094	0.062	0.025	0.190	0.085	0.050	0.063	0.057	0.057	**0.190**	0.063	0.347
Weight of fruit (g)	0.005	0.017	0.004	0.002	0.029	0.013	0.029	0.015	0.006	0.028	**0.083**	0.650

diameter of fruit suggested that the environmental effects constitute a major portion of the total phenotypic variation and hence direct selection for these characters will be less effective. High heritability for the characters controlled by polygene might be useful to plant breeder for making effective selection. Johnson *et al.* (5) reported that the heritability estimates along with genetic advance is more useful than the resultant effect for selecting best genotypes, as it suggests the presence of additive gene effects. High estimates of genetic advance were recorded for yield/plant followed by no. of fruits/plant, no. of flowers/plant, plant height and no. of leaves/plant.

The information on heritability alone may be misleading but when used in combination with genetic advance, the utility of heritability estimates increases. In the present investigation, high genetic advance alongwith high heritability was observed for yield/plant followed by no. of flowers/ plant, no. of fruits /plant, no. of leaves/plant, plant height and no. of days to flower. It indicated that additive gene effects were more important than these characters, so the improvement in these traits would be more efficiently done through selection in the present materials. Depending upon the variability, heritability and genetic advance estimates, it could be predicted that improvement by direct selection was possible in okra for traits like no. of flowers/plant, length of fruit, no. of branches/plant, plant height and no. of fruits/plant. Results are in consonance with Yadav *et al.* (10).

Fruit yield/plant in okra is the result of the interaction of no. of inter – related characters . Therefore, selection should be based on these components characters after assessing their relation with fruit yield/plant. In the present experiment, the values of correlation at genotypic level were high than the phenotypic correlation, indicating that there is a strong inherent association between the various characters studied. The yield/plant showed positive and significant correlation with no. of flowers/plant, no. of fruits/branches, no. of fruits/plant, length of fruit and weight of fruit at genotypic and phenotypic levels (Table 3&4). This indicated that fruit could be improved by making selection on the basis of no. of flowers/plant, no. of fruit/branch, no. of fruits/plant and length of fruits. These finding are also similar with those Bendale (2), Mishra *et al*. (6) and Osekita *et al*. (7).

REFERENCES

1. Al-Jibouri, H.A. Muller, P.A. and Robinson, H.P.(1958). Genotypic and environmental variance and co-variance in a upland crop of interspecific origin. *Agro. J.,* **30:** 633-636.
2. Bendale,V.W. (2003). Genetic variability and correlation studies in okra [*Abelmoschus esculentus* (L.) Moench]. *Orrisa J. Hort*. 31(2):1=-1-4.
3. Burton, G.W.(1952). Quantitative inheritance in grass. *Pro. 6th* 11411. *Grassland Congress J.I.*: 277-283.
4. Deway, D. R. and Lu, K.H (1959). A correlation and path coefficient analysis of yield component of the crested wheat grass seed production. *Agron,* G.S.I: 575-578.
5. Johnson, H. W., Robinson, H. F. and Comstock, R. E. (1955). Estimates of genetic and environmental variability in Soybean. *Agron. J.* **47:** 314-318.
6. Mishra, R.S., Rath, U.K. and Sahu G.S. (1990). Association of biometric characters in Okra. *Orissa J. Agri. Res.,* **3**(1): 6-8
7. Osekita, O.S., Ariyo, O.J. and Kehinde, O.B. (2000). Variation and inter character association in the segregating F_3 papulation arising from two crosses of Okra. *J. Agri. Res*. **1**(1):32-36.
8. Panse, V.G. and Sukhatme, P.V. (1967). *Statistical Methods for Agricultural Workers*. I.C.A.R, New Delhi.
9. Thamburaj and Singh (2004). *Vegetables, tuber crops and spices.* Published by Directorate of information and publication of Agriculture (ICAR), New Delhi PP.
10. Yadav, Y.C.; Kumar, S. and Singh, R. (2012). Studies on genetic variability, heritability and genetic advance in cucumber (*Cucumis sativus* L.) *HortFlora Res. Spectrum,* **1**(1) : 34-37.

HortFlora Research Spectrum, 1(2): 145-148 (2012) ISSN : 2250-2823

BIOCHEMICAL CHANGES IN GUAVA FRUITS DURING STORAGE AS AFFECTED BY DIFFERENT METHODS OF HARVESTING FROM DIFFERENT POSITION OF TREE

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ABSTRACT: A study was carried out on the effect of position of the canopy and different methods of harvesting of guava to evaluate its chemical as well as mineral quality at the different period of storage. Matured healthy fruits of guava cv. 'Pant Prabhat' with uniform size were harvested with and without peduncle and with one leaf pair with the help of secateur to analyze the post harvest behaviour of fruit after three and seven days of storage. Time of maturity was influenced by position of fruits. Fruits from lower tree canopy mature earlier than rest of the canopy. There was also a variation in chemical as well as mineral quality between different canopy positions on tree. Calcium and potassium contents were higher in upper canopy positions than lower canopy fruits. Fruits should be harvested lower layer of fruit tree canopy for better quality as well as storage. Therefore, at the time of harvesting guava the pedicel should remain attached to its fruit for better storage quality.

Keywords : *Guava, canopy, biochemical changes, storage.*

Guava is an important fruit crop grown widely in tropical and subtropical regions of the world. Although, quite inexpensive in countries of its production, guava is a delicious fruit which is very nutritious and exceptionally rich in ascorbic acid and several minerals useful for human health (Tandon and Chandha, 11; Wilson, 13). To those fruit lovers who familiarized with its penetrating aroma, guava is considered as one of the most detectable and fascinating fruits (Menzel, 8). Besides its exceptionally high nutritive values, guava is also prolific and regular bearer that could produce fruit year round. Position on the tree has been found to influence fruits in many fruit crops, *e.g.,* guava, grapefruit, mango, peach, pear etc. The quality of guava fruits depends on maturity at which fruits were harvested and ultimately storage behaviour. The effect of canopy position on fruit quality revealed that fruits on top positions are more susceptible to diseases than lower and middle canopy fruits (Wallace, 12).

Considering the above facts, present investigation was under taken to assess effect of different methods of fruit harvesting from various positions of tree canopy on fruit quality of guava cv. 'Pant Prabhat' during storage.

Received : 17.1.2012 *Accepted : 8.2.2012*

MATERIALS AND METHODS

A study was under taken at the Horticultural Research Centre, Patharchatta with guava cultivar Pant Prabhat, during the year 2009. The trees were divided into three layers-upper, middle and lower. Twenty fruits were harvested from each layer by different methods; with peduncle, without peduncle and with one leaf pair. The uniform size fruits were harvested from each position of trees from winter season crop. The harvested fruits of each category were divided into 3 lots. The design for experimentation was randomized design with nine treatments, three replications and 5 fruits per replication were taken. Just after harvesting one lot of fruits was analyzed and rest lots were stored at room temperature of 24 ± 2°C with relative humidity of 70-75 per cent. The remaining two lots were analyzed after 3 and 7 days of storage, respectively to assess the ripening behaviour and post harvest changes in chemical and mineral properties of the fruits. The total soluble solids concentration (T.S.S. %) was determined with the help of hand refractometer and results were expressed in terms of °Brix. The total pectin content was estimated for fruits as calcium pectate by the methods described by Ranganna (9). The ascorbic acid content was

estimated by 2,6-diochlorophenol indophenols dye expressed in terms of magnessium of ascorbic acid per 100g of fruit pulp (Ranganna, 9). Potassium content in fully ripened guava fruits was imated in percentage through procedure discussed by Ranganna (9). Magnesium and calcium content in guava fruits was precipitated as magnesium ammonium phosphate and calcium pectate. The data was analyzed statistically by analysis of variance (Fedrer, 3).

RESULTS AND DISCUSSION

Total soluble solids among the various treatments (Table 1) showed significant variations. Lower canopy fruits were found better in T.S.S content as compared to upper or middle canopy fruits. Maximum T.S.S. (9.83°Brix) was found in upper canopy fruits with peduncle at harvesting (T_2) and followed by 9.67° Brix in upper canopy fruits without peduncle at harvesting (T_1). While, minimum T.S.S. content of 7.93° Brix was found in treatment T_1 (upper canopy fruits without peduncle at 7 days of storage) and followed by 8.00° Brix in upper canopy fruits with peduncle at 3 days of storage (T_2).

The quantity and quality of fruits were significantly affected by the position of the fruits on the tree. The outside fruits had significantly higher T.S.S. and lower per cent of acid than the inside fruits. This resulted in higher T.S.S. acid ratios for the outside fruit than fruit from inside. Generally fruits from the top canopy positions have the lowest per cent of acid values. Total soluble solids were higher in fruits from the middle sector than from the remaining sectors and per cent juice showed no consistent pattern that can be associated with canopy position. The fruits from shaded portion that is middle and lower canopy of the tree contained both greater soluble solids and starch reserves while lower acidity in fruits. These results are in accordance with the findings of Barritt *et al*. (1) and Syvertsen and Albrigo (10).

The data (Table 1) on pectin content shows that pectin content (%) differed significantly among the treatments. Maximum pectin content (0.97%) was found in upper layer fruits with one leaf pair just after harvesting (T_3) and followed by 0.87% in upper layer fruits with one leaf pair at 3 days of storage (T_1). However, minimum pectin content (0.23%) was in middle layer fruits with peduncle at 7 days of storage (T_5) followed by 0.30% in lower layer fruits without peduncle at harvesting (T_7).

The data in Table 2 show that the variation in magnesium concentration differed significantly among the various treatment combinations. Maximum percentage (1.50%) of magnesium content was found in lower canopy fruits with one leaf pair at harvesting (T_9) followed by 1.47% in lower canopy fruits with one leaf pair after 3 days of storage (T_9). While, minimum percentage (0.10%) of magnesium content was found in middle canopy fruits with peduncle at harvesting (T_5) followed by 0.10% in middle canopy fruits with one leaf pair after 7 days of storage (T_6).

Fruiting position within the tree canopy has direct effect on fruit mineral content and quality. Fruits in the lower canopy have been mainly shown to have higher calcium concentrations but lower magnesium and potassium concentrations than in fruits from upper canopy. The fruit position on the outside of the canopy also accounted for substantial variation in mineral composition. It was observed that the fruits on terminals had higher average calcium and magnessium content. These results are in accordance with the findings of Ferre and Palmer (4) and Jones *et al.* (7).

The data presented in Table 2 show that potassium concentration (%) differed significantly among the various treatment combinations during storage. Maximum percentage (1.27%) of potassium concentration was recorded in lower region fruits with peduncle at harvesting (T_8) followed by 1.23% in lower region fruits with one leaf pair at harvesting (T_9). However, minimum percentage of potassium concentration 0.12% was observed in middle region fruits with peduncle after 3 days of storage (T_4) followed by 0.17% in middle region fruits with peduncle at harvesting (T_4).

Table 1: Effect of fruit positions and methods of harvesting on T.S.S. and pectin content of guava cv. Pant Prabhat during storage.

Treatment	Total soluble sugar (°B)			Pectin content (%)		
	At harvest	After 3 days	After 7 days	At harvest	After 3 days	After 7 days
T_1	9.67	8.40	7.93	0.37	0.87	0.17
T_2	9.83	8.00	8.07	0.47	0.57	0.33
T_3	9.57	8.00	8.40	0.97	0.30	0.27
T_4	8.70	7.93	8.70	0.30	0.63	0.23
T_5	8.40	8.07	8.40	0.57	0.37	0.23
T_6	8.07	8.40	8.07	0.43	0.57	0.37
T_7	8.83	8.23	8.67	0.30	0.60	0.47
T_8	7.93	8.00	8.90	0.63	0.60	0.53
T_9	8.83	8.40	8.83	0.33	0.57	0.60
CD (P = 0.05)	0.53	0.23	0.59	0.34	0.17	0.21

Table 2: Effect of fruit positions and methods of harvesting on magnesium content of guava cv. Pant Prabhat during storage.

Treatment	Magnesium (%) in fruits			Potassium (%) in fruits			Calcium (%) in fruits		
	At harvest	After 3 days	After 7 days	At harvest	After 3 days	After 7 days	At harvest	After 3 days	After 7 days
T_1	0.90	0.71	0.60	0.80	0.60	0.70	1.00	0.64	0.72
T_2	0.20	0.62	0.69	0.80	0.70	0.60	0.77	0.72	0.60
T_3	0.57	0.40	0.50	0.53	0.61	0.62	0.60	0.71	0.64
T_4	0.34	0.54	0.59	0.17	0.12	0.27	0.24	0.64	0.53
T_5	0.10	0.16	0.19	0.27	0.25	0.42	0.77	0.27	0.58
T_6	0.10	0.26	0.10	0.43	0.18	0.50	0.50	0.70	0.72
T_7	1.37	1.38	1.02	0.60	0.70	0.53	1.13	0.62	1.36
T_8	1.37	1.04	1.00	1.27	1.22	1.20	1.53	1.24	1.27
T_9	1.50	1.47	1.28	1.23	1.01	1.02	1.57	1.40	1.40
CD (P = 0.05)	0.18	0.16	0.15	0.19	0.12	0.10	0.20	0.18	0.19

The fruits developed under high light conditions were larger and had lower concentration of potassium and magnesium while the fruits developed under low light conditions were smaller but had higher amount of potassium and magnessium. It was also observed that the potassium concentration in shaded fruits was slightly higher than unshaded fruits, although, they were smaller in size. Thus, it was concluded that fruits from the upper parts of the canopy had a lower potassium content and susceptible to diseases than the fruits from the middle or lower parts of the tree canopy. These results are in accordance with the findings of Jackson *et al.* (5).

The data (Table 2) show that calcium concentration (%) differed significantly among the various treatment combinations during storage of 7 days. Maximum percentage (1.57%) of calcium content recorded was in lower canopy fruits with one leaf pair at harvesting (T_9) followed by 1.40% in lower canopy fruits with one leaf pair at 3 days of storage (T_9). Whereas, minimum percentage of calcium content (0.243%) was observed in middle canopy fruits without peduncle at harvesting (T_4) followed by 0.27% in middle canopy fruits with peduncle after 3 days of storage (T_5).

All elemental concentration were higher in bottom canopy fruits than the upper position. Reductions from bottom of the canopy to the top

were greatest for N (-32%), Zn (-27%), Ca (-20%), and Fe (-19%). These results are in conformity with the findings of Barritt *et al*. (1).

Differences in positions have pronounced effects on almost all aspects of fruit quality. There was also an adverse effect of shading on fruit size, mineral composition, yield and quality. The effect of light on fruit colour may be due to its influence on fruit nitrogen and carbohydrate concentrations and directly on anthocynin formation in the skin. The fruits developed under high light conditions were larger and had lower concentration of calcium while the fruits developed under low light conditions were smaller but had higher amount of calcium. Thus, it was concluded that the fruits from the upper parts of tree canopy had a lower calcium content and susceptible to diseases than the fruits of similar size from the middle or lower parts of the tree canopy. These results are in accordance with the findings of Farhoomand *et al.* (2) and Jackson *et al.* (5).

In conclusion, substantial variation was observed in chemical and mineral contents of fruits located on different positions of tree canopy. This study suggests that the fruits from bottom and middle canopy are better in quality aspects either chemical or mineral. Although there are some positional differences on fruit quality from different canopies of tree, but the fruits from upper canopy were good in colour texture only and some mineral content. Thus the fruits from middle and lower canopy should be preferred better in storage quality as well as mineral and chemical quality.

REFERENCES

1. Barritt Bruce, H., Rom, Curt, R., Guelich, Kurt, R. and Drake, S.R. (1987). Canopy position and light effects on spur, leaf and fruit characteristics of Delicious Apple. *Hort. Sci.,* **22:** 402-405.
2. Farhoomand, M.B., Patterson, M.E. and Chu, C.L. (1977). The repening pattern of Delicious' apples in relation to position on the tree. *J. Amer. Soc. Hort. Sci.,* **102:** 771-779.
3. Federer, W.T. (1977). Randomized complete block design. In *Experimental Designs*. Oxford and IBH Publishing Co. New Delhi. 86 pp.
4. Ferre, D.C. and Palmer, J. W. (1982). Effect of spur defoliation and ringing during bloom in fruiting, fruit mineral level and net photosynthesis of 'Golden Delicious' apple. *J. Amer. Soc. Hort. Sci.,* **107:** 1182-1186.
5. Jackson, J. E., Perring, M. A., Sharples, R. O. and Palmer, J.W. (1977). Effects of shade on growth and cropping of apple trees. Effects on fruit growth, chemical composition and quality at harvest and after storage. *J. Hort. Sci.,* **52:** 267-282.
6. Jackson, J. E., Sharples, R. O. and Palmer, J. W. (1971). The influence of shade and within tree position on apple fruit size, colour and storage quality. *J. Hort. Sci.,* **46** : 277-287.
7. Jones, H.G., Palmer, J.W., Rom, C.R. and Mackenzie, K.A.D. (1991). Water relations of 'Wijcik Mcintosh' apple trees. *J. Hort. Sci.,* **66 :** 322-317.
8. Menzel, C. M. (1985). Guava is an exotic fruit with potential in Queensland. *Queensland Agri. J.,* **111**(2) : 93-98
9. Ranganna, S. (1986). *Handbook of analysis and quality control of fruits and vegetables products*. 2nd Ed. New Delhi. Tata Mc Grow Hill Publishing Company Ltd. 19 pp.
10. Syvertsen, J.P. and Albrigo L.G. 1980. Effects of grapefruit tree canopy position on microclimate, yield and juice quality. *J. Amer. Soc. Hort. Sci.,* **105** (3) : 454-459.
11. Tandon, D.K. and Chadha, K.L. (1994). Physico-chemical characteristics of some guava varieties. *Prog. Hort.,* **15 :** 42-44.
12. Wallace, T. (1953). Some positions factors affecting the core in McIntosh apples. *J. Amer. Soc. Hort. Sci.,* **47 :** 67-74.
13. Wilson, C.W. (1980). *Guava.* S. Nagy and P. E. Shaw(eds), Tropical and sub tropical fruits: Composition and properties and values.AVI, Westport, CT. p. 279-299.

HortFlora Research Spectrum, 1(2): 149-152 (2012) ISSN : 2250-2823

STANDARDIZATION OF BENCH GRAFTING IN CUSTARD APPLE (*Annona squamosa* L.)

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ABSTRACT : An experiment on bench grafting in custard apple (*Annona squamosa* L.) employing cleft grafting technique was conducted at Indian Grassland and Fodder Research Institute, Jhansi during 2007. Bare rooted stocks of custard apple having 0.6 cm diameter were bench grafted with dormant scion of cv. *Balanagar.* Dormant scion shoots having 0.6 cm thickness used for grafting has given highest graft success (96.4%) when it was performed during 29th May, whereas minimum (37.8%) was recorded when 0.8 cm thick scion was grafted on 6th June. Days taken to sprouting, length of sprout, collar diameter, number of secondary branches and number of secondary roots per plant were significantly influenced by scion thickness and time of grafting.

Keywords : *Custard apple, bench grafting, time of grafting, scion thickness.*

Custard apple (*Annona squamosa* L.), belongs to family Annonaceae, is one of the most delicious fruit crop of semi arid ecosystem. It is also known as *sitaphal*, sugar apple, sweet sop and *sarifa*. Due to its hardy in nature and escape from animal damage, custard apple has become naturalized in many tropical and subtropical parts of world. It is drought hardy plant, which can be grown in shallow soil without much care. Leaf shedding phenomenon during moisture stress period is its characteristic feature to be grown under arid and semi arid condition. The area under custard apple reported to be more than 40,000 ha mainly found in wild forms in Gujarat, Andhra Pradesh, Tamil Nadu, Orissa, Assam and Rajasthan (Chundawat, 2). Ripe fruits are rich in sugars and are generally consumed as fresh fruit, but are also widely used in semi- processed and processed products such as juice, jam and ice cream. Essential oil, can be extracted from its seed, has great medicinal and insecticidal value due to content of a number of chemical compounds including flavonoids, alkaloids and accetogenins. Its leaf shedding phenomena during moisture stressed period is its characteristic feature to be suited under semi arid ecosystem therefore it can be grown grown up to 600 mm rainfall / annum (Annon., 1) . It leaves contain annonine which escaped animal from grazing. Therefore, it also offers great potential for agroforestry. Ram *et al*. (7) reported its suitability under hortipastoral system in semi-arid situation. Custard apple is commonly propagated by seed which shown unevenly and irregularly due to taking of long time, depending on seed maturity and dormancy as well as variability in characteristics. Very little literature is available on vegetative propagation of custard apple. Rajput (6) reported that whip grafting found to be better than budding and Nair *et al.* (4) reported *in vitro* propagation of *Annona* hybrids (*A. squamosa* L. *A. cherimolia* L.). Very often plants give poor establishment in field on account of root damage while lifting plants from nursery. Transport of plants to long distance incur heavy expenditure besides practical difficulties, mortality of plants during transport in order to combat these problems an experiment on "standardization of bench grafting" with scion thickness and time of grafting was conducted .

Received : 31.1.2012 *Accepted : 27.2.2012*

MATERIALS AND METHODS

An experiment was conducted during 2007 to standardize bench grafting in custard apple (*Annona squamosa* L.). For the purpose, one year old rootstocks having uniform thickness (0.6 cm) were selected. The dormant scion shoots of cv. Balanagar with four thicknesses (diameter) viz; 0.5,

0.6, 0.7 and 0.8 cm were selected for bench grafting employing cleft method. The grafting operations were performed on 15th, 22nd, 29th May and 6th June 2007 with all four thickness. The experiment was laid out in randomized block design with three replications. Each treatment contained five grafted plants and total 240 grafts were made in this experiments. After grafting, bare rooted grafts were planted in polythene bags (22 x 15cm) duly filled with soil + FYM + leaf mould in the ratio of 1:1:1. Immediately after placing grafts in polythene, these were covered with a poly cap having size of 20 x 2.5 cm. Lower open top end of cap was buried in filling mixture to check evapo-transpiration loss and desiccation of grafts. Thereafter, they were kept under partial shade and watered them properly. Subsequently, watering and weeding were done as per the requirements. The cap was removed after a week of scion sprouting. Only one shoot from scion was allowed to grow. Observations on days to initiate sprouting, graft success and shoot growth and number of secondary roots (on 30th August at planting) were recorded.

RESULTS AND DISCUSSION

Sprouting and graft success

Days required to sprouting were influenced with scion thickness and time of grafting (Table 1). The initial sprouting was achieved significantly earlier (19.53 days) with thickest scion (0.8cm) when compared to other thickness of scions. Similarly, the grafting performed on 29th May have also taken least duration (19.05 days) as compared to before and late grafting. The graft made on 29th may with thickest scion produced early sprouting (16.5 days) as compared to rest of the treatment combinations. Early sprouting with thick scion may be attributed to greater amount of reserve food material (carbohydrates) in the scion shoot and early union owing to more surface contact between scion and root stock (Hartman and Kester, 3; and Pathak, 5). The thick scion grafted on 29th May showed earlier sprouting might be due to callusing and union have started in the graft has got favourable climate and scion come to active period after completing dormancy period during summer in subtropical region of Uttar Pradesh. Tewari *et al.* (10) have also reported that graft union was influenced with scion thickness in aonla. They also found that bench grafting in aonla on 15th of January, February and March gave 46.0, 83.3 and 26.6 per cent of success, respectively.

The final graft success percentage was recorded at plantable stage and found that this attribute was significantly affected with scion thickness and time of grafting. Table 1 showed that the graft success with same thickness of scion (0.6 cm) and stock was significantly higher (71.9%) as compared to other scion thickness, which ranged from 49.5-59.8 per cent. Similarly, before or late grafting from 29th May (78.5%) significantly declined the graft success. The grafting made on 6th June gave very poor success (44.6%). The scions having 0.6 cm thickness and grafted on 29th May reported to significantly higher success (95.4%) when compared to rest of the treatments. Tewari and Bajpai (12) reported that in aonla graft success was influenced with scion thickness. They also reported that critical diameter for grafting in aonla is 0.5 cm and if the scion is 0.1 cm thicker than rootstock gave higher success. Tewari *et al.* (11) also reported that dormant scion gave better performance in bench grafting in *ber* as compared to active scion because of better callusing and proper union of stock and scion.

Shoot growth

Length of shoot was also influenced by relative thickness of scion and time of grafting (Table 2). The thick scion (0.8 cm) showed early sprouting and continuous growth after grafting resulted significantly longer shoot (24.35 cm) followed by 0.6 cm thickness of scion (20.9 cm). The thin scion (0.5 cm) produced shortest shoot length (18.03 cm) at the plantable stage of grafting. Similarly Singh *et al.* (8) reported that budling height was influenced with rootstock thickness and height of budding on root stock in ber. Tewari *et al.* (9) reported in aonla that the graft made on 15th February gave 84.6 cm length sprout when compared to15th January (83.6 cm) and 15th March (77.0 cm) . The thickest scion (0.8 cm) when grafted on 29th May gave longest sprout (31.6 cm) as compared to all graft combinations. This might be resumed food material along with optimum time of grafting.

Table 1: Effect of scion thickness and time of grafting on sprouting and graft success percentage of custard apple.

Date of grafting	Days taken to sprout					Graft success percentage				
	Scion thickness (cm)				Mean	Scion thickness (cm)				Mean
	0.5	0.6	0.7	0.8		0.5	0.6	0.7	0.8	
15th May	23.2	23.1	22.2	21.5	22.50	42.1	62.5	56.3	42.9	50.95
22nd May	19.8	19.5	19.5	19.8	19.65	51.1	72.7	61.6	53.8	59..8
29th May	20.6	20.6	18.5	16.5	19.05	74.2	96.4	80.1	63.3	78.5
6th June	23.1	23.1	20.0	20.3	21.43	43.3	56.2	41.2	37.8	44.6
Mean	21.68	21.68	20.5	19.53		52.7	71.9	59.8	49.5	
CD (P = 0.05)	Thickness Days T x D	0.73 0.73 1.46				1.42 1.42 2.84				

Table 2: Effect of scion thickness and time of grafting on vegetative growth of shoot at planting.

Date of grafting	Length of sprout (cm)					Collar diameter of sprout (cm)				
	Scion thickness (cm)				Mean	Scion thickness (cm)				Mean
	0.5	0.6	0.7	0.8		0.5	0.6	0.7	0.8	
15th May	15.3	18.3	15.8	19.6	17.25	2.21	0.32	0.29	0.28	0.28
22nd May	21.3	19.6	15.6	22.8	19.83	0.31	0.35	0.29	0.32	0.32
29th May	17.9	21.8	21.5	31.6	23.2	0.32	0.41	0.38	0.36	0.37
6th June	17.6	23.9	18.6	23.4	20.88	0.21	0.31	0.27	0.26	0.26
Mean	18.03	20.9	17.88	24.35		0.26	0.35	0.31	0.31	
CD (P = 0.05)	Thickness Days T x D	1.29 12.9 2.586				0.0802 0.0802 NS				

Table 3: Effect of scion thickness and time of grafting on secondary branches and secondary roots at planting.

Date of grafting	No. of secondary roots / plant					No. of secondary root / plant				
	Scion thickness (cm)				Mean	Scion thickness (cm)				Mean
	0.5	0.6	0.7	0.8		0.5	0.6	0.7	0.8	
15th May	2.7	4.6	3.5	2.3	3.28	24.5	25.4	20.3	22.9	23.28
22nd May	3.4	5.3	4.1	2.3	3.78	22.3	26.8	24.7	21.8	23.9
29th May	4.5	6.8	5.1	2.3	5.45	24.6	28.3	25.9	26.8	26.4
6th June	1.2	3.4	2.6	5.4	2.40	21.3	22.8	20.3	19.9	21.01
Mean	2.95	5.03	3.83	2.4		23.18	25.83	22.8	22.85	
CD (P= 0.05)	Thickness Days T x D	0.317 0.317 0.628				2.177 2.177 NS				

The graft made with 0.6 cm thickness of scion showed significantly higher collar diameter of sprout (0.35 cm) at the base of sprouting followed by thicker scion (Table 2). The thinnest scion showed minimum thickness of sprout (0.26cm). The thickness of sprout was also significantly influenced with operation time of grafting. The graft made over on 29th May produced significantly thicker sprout (0. 37 cm) when compared to early or late grafting.

Secondary branches and roots

The secondary branches produced by grafted sprout influenced with scion thickness and time of grafting. The data (Table 3) revealed that 0.6 cm thick scion produced significantly higher number of branches per plant (5.03) followed by second (3.83) and third thickness (3.10). It might be due to same thickness of rootstock and scion performed at optimum time makes a congenial union resulted better growth of grafts. Similarly, the graft made on 29th May produced maximum number of secondary branches per plant.

The number of secondary roots plays an important role in establishment of grafted plant during nursery stage and field transplanting also. The scion with 0.6 cm thickness produced significantly higher number of secondary roots per plant (25.83) as compared to rest of the thickness of scion. Similarly, the graft made on 29th May produced 26.4 secondary roots/plant when compared to graft made on 15th, 22nd May and 6th June (23.28, 23.9 and 21.01 secondary roots / plant, respectively). The root attribute mainly depends on seedling growth and management practices. However, due to compatible union between stock and scion gave good source and sink relation as a result maximum number of secondary roots recorded with this treatment.

From the above results, it is clear that when one year old custard apple seedlings are bare rooted and bench grafted though cleft grafting method with 0.6 cm thickness of improved cultivar scion at the end of May month got 96.4 per cent success quality planting material at the time of planting (30th August).

ACKNOWLEDGEMENT

The authors are thankful to the Director and Head of the Division for providing facility to conduct this experiment.

REFERENCES

1. Anonymous, (2005). Fruits for future *Annona. International Centre for Underutilized Crops. Institute of Irrigation and Development Studies, University of Southampton, Southampton,* SO 17 1 BJ, U.K. Factsheet No. 5, March 2005.
2. Chundawat, B.S. (1990). *Arid Fruit Culture. Oxford & IBH Publishing Co. Pvt. Ltd.* New Delhi, India. pp. 118-123.
3. Hartman, H. T. and Kester, D.E. (1986). *Plant Propagation. Prentic – Hall of India, Pvt. Ltd*. New Delhi. India. pp. 399-447.
4. Nair, S., Gupta, P.K. and Mascarenhans, A.F. (1984). *In vitro* propagation of *Annona* hybrids (*A. squamoas* L. *A. cherimolia* L.). *Indian J. Hort.*, **41:** 160-65.
5. Pathak, R.K. (1990). *Phal Briksh Pravardhan. ICAR,* New Delhi, India. pp. 92-138.
6. Rajput, C.B.S. (1985). Custard apple: In: *Fruits of India-Tropical and Sub tropical* (ed) T.K. Bose, Naya Prokash, Calcutta, pp 479- 486.
7. Ram, S.N., Kumar, Sunil, Roy, M.M. and Baig, M.J. (2007). Effect of legume and fertility levels on buffel grass (*Cenchrus ciliaris*) and annona (*Annona squamosa*) grown under horti-pastoral system. *Indian J. Agron.,* **51** (4): 278-282.
8. Singh, K., Singhrot, R.S. and Chauhan, K.S. (1981). Effect of budding height and diameter of rootstock on budding success and budling growth of ber. *Haryana J. Hortic. Sci.*, **10** (1/2) : 69-71.
9. Tewari, R.K., Bajpai, C.K. and Rai, P. (2005). Production and establishment of aonla through bench grafting. *ICAR News,* **11** (1): 9.
10. Tewari, R.K., Bajpai, C.K. and Dwivedi, R.P. (2005). Bench grafting in aonla. *Indian J. Agric. Sci.,* **75** (5) : 296-7.
11. Tewari, R.K. Bajpai, C.K. and Kumar Sunil (2007). Bench grafting in ber (*Zizyphus spp.*). *Indian J. Agric. Sci.,* **77** (4): 239-40.
12. Tewari, R.K. and Bajpai, C.K. (2002). Propagation of Aonla (*E. officinalis*) through grafting in polybags. *Indian J. Agric. Sci.,* **72:** (6):353-354.

HortFlora Research Spectrum, 1(2): 153-157 (2012) ISSN : 2250-2823

EFFECT OF PRE-HARVEST TREATMENTS OF CALCIUM SALTS ON HARVEST MATURITY IN KINNOW MANDARIN

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ABSTRACT : The present study was undertaken at Punjab Government Progeny Orchard and Nursery, Attari, Amritsar, to judge the efficacy of different levels of Calcium Chloride ($CaCl_2$) and Calcium Nitrate {$Ca(NO_3)_2$} for retaining the fruit quality during delayed harvesting. There were six chemical treatments and the experiment was replicated three times. The fruits from the trees were harvested at different stages of maturity (1st January, 15th January, 1st February and 15th February) and were subjected to physico-chemical evaluation. On the basis of two years observation, Calcium Chloride ($CaCl_2$) at 6 per cent and Calcium Nitrate {$Ca(NO_3)_2$}at 0.3 per cent proved their effectiveness in delaying the harvest maturity of the fruits. However, the TSS, total sugars and reducing sugars level of these treated fruits was find to be lower in comparison to control. The acidity level was recorded to be higher than control.

Keywords : *Calcium chloride, calcium nitrate, apparent maturity.*

In India *Citrus* is grown in an extremely varied conditions, right from arid and semi-arid areas of Rajasthen, Punjab and Haryana to humid tropical areas of north-east India, considered to be the possible place from where citrus has travelled to countries which are today claimed to have revolutionarised the art of citrus production. This has given citrus a status of most promising fruit crop which has a great scope of world trade (Singh and Srivastava, 14). Mandarins are the most prominent among citrus fruits in India. The mandarin cultivar Kinnow occupies a predominant position in Punjab and has become a highly successful commercial fruit crop.

A large plantation has been brought under Kinnow fruit crop during the last two decades in Punjab, consequently, increased production is posing serious handling problems and invites research on expanding the harvesting maturity. As the harvesting of Kinnow is confined to a limited period, market glut is the serious problem faced by the growers, which engage the attention of horticulturists to delay its harvesting period. This process can help to overcome the hurdles in further expansion and regulation of marketing. In our country, cool chain system has not developed yet which necessitates to find out alternative measures for regulated market.

The efficiency of calcium salts in checking the time of harvesting in citrus has been advocated by very few investigators. Calcium salts are known to be involved in number of physiological processes concerning membrane structure, functioning and enzyme activity. The investigations were conducted with the aim to find out the possibility of expanding the harvesting period with the help of $CaCl_2$ and $Ca(NO_3)_2$ along with their threshold levels.

MATERIALS AND METHODS

The uniform and disease free trees of Kinnow of 15 years age were selected for the investigations from 'Punjab Government Progeny Orchard' Attari, Amritsar. All the plants were applied with standard doses of fertilizers and plant protection measures as recommended by Punjab Agricultural University, Ludhiana. The pre-harvest treatments of Calcium Chloride ($CaCl_2$) 4, 6 per cent, Calcium Nitrate {$Ca(NO_3)_2$} 0.1, 0.2 0.3 per cent and control (Spray of water) were applied on 25th October during both the experimental years.

During the experiment 6 treatments were carried out. Two trees were kept as unit treatment

Received : 15.1.2012 *Accepted : 8.2.2012*

and replicated three times. The harvesting maturity of the treated trees was judged by harvesting the fruits on four different stages, viz. January 1st, January 15th, February 1st, and February 15th. The observations were recorded for TSS, Acidity, TSS: Acid ratio, total sugars and reducing sugars in relation to apparent maturity.

RESULTS AND DISCUSSION

All the calcium salt treatments showed significantly lower TSS value over control (Table 1). The minimum level of the parameter was recorded with $Ca(NO_3)_2$ at 0.3 per cent followed by $CaCl_2$ at 6 per cent. The lower TSS level in the calcium treated fruits may be due to low respiration rate which could have slowed down the conversion of starch and other polysaccharides in sugars (Mukherjee and Datta, 9). Decrease in TSS with calcium application has been observed by Sandhu *et al.* (11) in Kinnow fruits. There was a continuous increase in TSS with each delay in harvesting date. This might be due to deposition of sugars in the fruits as polysaccharides. Increased TSS was also observed with advancement of maturity by Singh *et al.* (13) in Kinnow.

The data presented in Table 2 reveal that the treatments of calcium produced fruits with higher acid content. The maximum level of acidity was observed in the fruits from the plants treated with $CaCl_2$ at 6 per cent and $Ca(NO_3)_2$ at 0.3 per cent. The higher acid content of the Kinnow fruits with calcium application may be attributed to its role in lowering membrane permeability and hence reduced respiration rate (Godara *et al.,* 4). Similar results have also been reported by Ramakrishna *et al.* (10) in papaya. As a general trend towards maturity, the acidity periodically decreased in all the treatments. Decline in acidity during ripening has also been reported in citrus by Joolka and Awasthi (6).

The significantly lower level of TSS/acid ratio than control was observed in the fruits from the treatment of $Ca(NO_3)_2$ at 0.3 per cent which was closely followed by $CaCl_2$ at 6 per cent (Table 3). The decrease in TSS/acid ratio with calcium application can be attributed to lower gap between the TSS and acid level of the fruits. The present results relating to calcium treatments corroborate the previous findings of Brahmachari *et al.* (2) in guava. The extension of harvest period at each interval resulted in a general increase in TSS/acid ratio. This increase can be attributed to regular increase of total sugars and decrease of acidity as the natural phenomenon of ripening. Similar increase in TSS/acid ratio with delayed harvesting was observed by Ladaniya (8), though the increase was non-significant.

The data in Table 4 and 5 regarding total sugars and reducing sugars, respectively depicts that all the calcium treatments registered significantly lower level of the total and reducing sugars. The $Ca(NO_3)_2$ treatment at 0.3 per cent resulted in lowest sugars content. The decrease in the sugar content of the calcium treated fruits may be attributed to the fact that calcium probably reduces the respiration rate and the hydrolysis of starch into sugars (Faust and Klein, 3). These results are in confirmation with the findings of Ramakrishna *et al.* (19) in papaya.

Delay in harvesting date recorded a continuous increase in reducing as well as total sugars of the fruits in all the treatments. This might be due to conversion of polysaccharides, the complex sugars into monosaccharides, the simple sugars. The findings of the present study are in conformity with those of Goswami *et al.* (5) and Singh *et al*. (13) in Kinnow mandarin.

$Ca(NO_3)_2$ at 0.3 per cent and $CaCl_2$ at 6 per cent played a key role in delaying the maturity as the fruits of these treatments were last to attain the maturity (Between 1st February and 15th February) amongst all the treatments (Table 6). In the rest treatments, except control, maturity stage was attained between 15th January and 1st February. The delayed maturity due to calcium has been explained by Bangerth *et al.* (1) who suggested that calcium could have reduced the endogenous substrate catabolism during respiration by limiting

Table 1: Effect of calcium salts on TSS level (per cent) of kinnow fruits harvested at different dates.

Treatments	Harvesting Dates				
	1st Jan	15th Jan	1st Feb	15th Feb	Mean
$CaCl_2$ 4%	9.18	9.34	9.51	9.71	9.44
$CaCl_2$ 6%	9.08	9.21	9.40	9.50	9.30
$Ca(NO_3)_2$ 0.1%	9.23	9.44	9.55	9.74	9.49
$Ca(NO_3)_2$ 0.2%	9.17	9.42	9.53	9.71	9.46
$Ca(NO_3)_2$ 0.3%	9.08	9.22	9.36	9.46	9.28
Control	10.08	10.19	10.34	10.50	10.28
Mean	9.30	9.47	9.62	9.77	

CD(P=0.05) : Treatments (A) – 0.51; Harvesting dates (B) – 0.31; A×B – NS

Table 2: Effect of calcium salts on acidity level (per cent) of kinnow fruits harvested at different dates.

Treatments	Harvesting Dates				
	1st Jan	15th Jan	1st Feb	15th Feb	Mean
$CaCl_2$ 4%	0.85	0.83	0.79	0.76	0.81
$CaCl_2$ 6%	0.88	0.85	0.82	0.79	0.84
$Ca(NO_3)_2$ 0.1%	0.85	0.82	0.79	0.77	0.81
$Ca(NO_3)_2$ 0.2%	0.87	0.83	0.80	0.78	0.82
$Ca(NO_3)_2$ 0.3%	0.89	0.85	0.82	0.80	0.84
Control	0.80	0.76	0.74	0.71	0.75
Mean	0.86	0.82	0.79	0.77	

CD (P=0.05) :Treatments (A) – 0.03; Harvesting dates (B) – 0.02; A×B – NS

Table 3: Effect of calcium salts on TSS/acid ratio of kinnow fruits harvested at different dates.

Treatments	Harvesting Dates				
	1st Jan	15th Jan	1st Feb	15th Feb	Mean
$CaCl_2$ 4%	10.80	11.32	12.74	12.77	11.91
$CaCl_2$ 6%	10.38	10.84	11.54	12.03	11.20
$Ca(NO_3)_2$ 0.1%	10.86	11.52	12.09	12.73	11.80
$Ca(NO_3)_2$ 0.2%	10.61	11.35	11.91	12.45	11.58
$Ca(NO_3)_2$ 0.3%	10.26	10.85	11.42	11.90	11.11
Control	12.59	13.50	14.07	14.79	13.74
Mean	10.92	11.56	12.30	12.78	

CD (P=0.05) : Treatments (A) – 0.42; Harvesting dates (B) – 0.25; A×B – NS

Table 4: Effect of calcium salts on total sugars level (per cent) of kinnow fruits harvested at different dates.

Treatments	Harvesting Dates				
	1st Jan	15th Jan	1st Feb	15th Feb	Mean
$CaCl_2$ 4%	5.93	6.12	6.22	6.34	6.15
$CaCl_2$ 6%	5.63	5.82	5.99	6.09	5.88
$Ca(NO_3)_2$ 0.1%	5.94	6.15	6.27	6.40	6.19
$Ca(NO_3)_2$ 0.2%	5.82	6.01	6.15	6.25	6.06
$Ca(NO_3)_2$ 0.3%	5.59	5.80	5.92	6.09	5.85
Control	6.56	6.73	6.84	6.96	6.77
Mean	5.91	6.11	6.23	6.36	

CD(P=0.05) : Treatments (A) – 0.18; Harvesting dates (B) – 0.11; A×B – NS

Table 5: Effect of calcium salts on reducing sugars level (%) of kinnow fruits harvested at different dates.

Treatments	Harvesting Dates				
	1st Jan	15th Jan	1st Feb	15th Feb	Mean
$CaCl_2$ 4%	3.03	3.05	3.09	3.16	3.08
$CaCl_2$ 6%	2.86	2.88	2.92	2.97	2.91
$Ca(NO_3)_2$ 0.1%	3.00	3.04	3.07	3.13	3.06
$Ca(NO_3)_2$ 0.2%	2.88	2.99	3.02	3.04	2.98
$Ca(NO_3)_2$ 0.3%	2.80	2.86	2.91	2.96	2.88
Control	3.33	3.36	3.39	3.43	3.38
Mean	2.98	3.03	3.06	3.12	

CD P=(0.05) : Treatments (A) – 0.09; Harvesting dates (B) – 0.06; AXB – NS.

Table 6: Effect of calcium salts on apparent fruit maturity (per cent).

Treatments	Harvesting Dates			
	1st Jan	15th Jan	1st Feb	15th Feb
$CaCl_2$ 4%	54	61	82	90
$CaCl_2$ 6%	47	54	66	84
$Ca(NO_3)_2$ 0.1%	61	67	84	98
$Ca(NO_3)_2$ 0.2%	55	59	82	91
$Ca(NO_3)_2$ 0.3%	47	56	61	88
Control	76	84	90	100

CD P=(0.05) : Treatments (A) – 0.92; Harvesting dates (B) – 0.73; AXB – NS.

the diffusion of substrate from vacuole to the cytoplasm and favoured the uptake of sorbital, thus disallowing its involvement in reactions related to internal breakdown. Jones *et al.* (7) contended that calcium controlled the disintegration of mitochondria, endoplasmic reticulum and cytoplasmic membranes and thus helped in retarding respiration rate and delaying maturity. Delay in fruit maturity with calcium application has been advocated by Sharma *et al.* (14) in Kinnow. The ascertained delay of apparent maturity by the chemical treatments can be of great utilization to prolong the harvest period thereby avoiding gluts, leading to ensured marketing for the Kinnow growers of Punjab and the adjoining states.

REFERENCES

1. Bangerth, F., Dilley, D. R. and Dewey, D. H. (1972). Effect of post-harvest calcium treatments on internal breakdown and respiration of apple fruits. *J. Amer. Soc. Hort. Sci.,* **97 :** 679-682.
2. Brahmachari, V. S., Kumar, Naresh and Kumar, Rajesh (1997). Effect of foliar feeding of calcium, potassium and growth substances on yield and quality of guava (*Psidium guajava* L.). *Haryana J. Hortic. Sci.*, **26**(3-4) : 169-173.
3. Faust, M. and Klein, J. D. (1973). Levels and sites of metabolically active calcium in apple fruits. *J. Amer. Soc. Hort. Sci.,* **99 :** 93-94.
4. Godara, A. K., Chauhan, K. S. and Kumar, Ashwani (2002). Effect of various pre-harvest treatments on the quality of Thompson Seedless grapes. *Haryana J. Hortic. Sci*. **31**(3-4) : 164-167.
5. Goswami, A.K., Shukla, H.S., Kumar, P. and Misra, D.S. (2012). Effect of pre-harvest application of micro-nutrients on quality of guava (*Psidium guajava* L.) cv. Sardar *HortFlora Res. Spectrum,* **1**(1) : 60-63.

6. Joolka, N. K. and Awasthi, R. P. (1980). Studies on maturity standards of Kinnow in Himachal Pradesh. *The Punjab Hort. J.,* **20**(3-4) : 149-151.
7. Jones, Wyn, R. G. and Lunt, O. R. (1970). The function of calcium in plants. *Bot. Rev.*, **36** : 407-423.
8. Ladaniya, M. S. (1997) Response of Nagpur mandarin fruit to pre-harvest sprays of gibberellic acid and carbendazim. *Indian J. Hort.,* **54**(3) : 205-212.
9. Mukherjee, S. K. and Dutta, M. N. (1967). Physico-chemical changes in Indian guava (*Psidium guajava* L.) during fruit development. *Curr. Sci.,* **36 :** 675-676.
10. Ramakrishna, M., Haribabu, K., Reddy, Y. N. and Purushotam, K. (2001). Effect of pre-harvest application of calcium on physico-chemical changes during ripening and storage of papaya. *Indian J. Hort.*, **58**(1) : 228-231.
11. Sandhu, S. S., Randhawa, J. S. and Dhillon, B. S. (1989). Effect of different forms of calcium, diphenylamine and bavistin on the shelf life of kinnow fruits. *Indian J. Hort.,* **46**(1-4) : 327-331.
12. Sharma, R. M., Yamdagni, R., Gaur, H. and Shukla, R. K. (1996) Role of calcium in Horticulture–A Review. *Haryana J. Hort. Sci.,* **25**(4) : 205-212.
13. Singh, H. K., Singh, S. N. and Dhatt, A. S., (1998). Studies on fruit growth and development in Kinnow. *Indian J. Hort.,* **55**(3) : 177-182.
14. Singh, Shyam and Srivastava, A.K. (2004). Citrus industry of India and overseas. *Adv. in Citriculture* : 9.

HortFlora Research Spectrum, 1(2): 158-161 (2012) ISSN : 2250-2823

EFFECT OF NUTRIENT MANAGEMENT THROUGH ORGANIC SOURCES ON THE PRODUCTIVITY OF GUAVA (*Psidium guajava* L.)

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ABSTRACT : The experiment was conducted to study the effect of nutrient management through organic sources on guava trees. Results showed that application of various organic substances increased growth of trees, fruit yield and fruit quality as compared to untreated ones (control). The highest values of these parameters were recorded for trees applied with poultry manure followed by the trees applied with FYM. Application of poultry manure on guava trees significantly increased number of fruits per plant and resultantly higher yield (kg/tree) was achieved as compared to control. The recorded values of total soluble solids and total sugar were also found significantly higher with the application of poultry manure.

Keywords : *Guava, nutrient management, organic sources, growth, productivity, quality.*

Guava (*Psidium guajava* L.) is one of the important fruit crops of tropical and sub-tropical regions of India. It is a hardy crop and can be grown satisfactorily on marginal soil with minimum care. It is popularly known as 'Apple of Tropics' and claims to be the fourth most important fruit in area and production after mango, banana and citrus with a production of 2270 thousand MT from an area of 204 thousand hectares with productivity of 11.1 MT/ha. Guava pulp is rich source of vitamin C (75-260 mg/100 g) and pectin (0.5-1.8 %). Guava is also a fair source of vitamin A, iron, calcium and phosphorus. In some countries the leaves are medicinally used against diarrhoea and for dyeing and tanning. Chemical based farming is not sustainable because of many problems such as loss of soil fertility from excessive erosion and associated plant nutrients loss, surface and ground water pollution from fertilizers and sediments, impeding shortages of non-renewable resources and low farm income from high production costs. In view of this there is an increasing awareness worldwide about alternative agricultural systems known as integrated plant nutrient management, which implies the maintenance or adjustment of soil fertility and plant nutrients supply for sustaining desired crop productivity through optimization of benefits from all possible sources of plant nutrients in an integrated manner (Ram *et al.,* 5). The soils of India are impoverished and hungry of plant nutrients. What needed is an optimum use of procured inputs and not of increasing inputs. Considering economy, energy and environment, it is imperative that plant nutrients should be used effectively by adopting proper nutrient management system to ensure high yield and to sustain the availability in soil at the optimum level for getting higher yield and quality fruit production for which nutrient management is necessary (Yadav, 7). Use of organic manures along with biofertilizers and crop residues as a cheap source of available nutrients to plants has resulted in beneficial effects on growth, yield and quality of various fruit crops (Katiyar *et al.,* 1). However, information are lacking on this aspect under semi arid climatic conditions of Vindhayan region.

MATERIALS AND METHODS

Experimental Location :

The experiment was carried out at the Agricultural Research farm of Rajiv Gandhi South Campus, (BHU) Barkachha, Mirzapur which is situated in Vindhyan region of district Mirzapur (25º 10' latitude, 82º 37' longitude and altitude of 427 meters above mean sea level). The climate of Barkachha, Mirzapur is typically semi-arid characterized by extremes of temperature both in summer and winter with low rainfall and moderate

Received : 9.2.2012 *Accepted : 5.3.2012*

humidity. Maximum temperature in summer is as high as 39.80°C and minimum temperature in winter falls below 9ºC. The annual rainfall of locality was 209.2 mm in 2010, of which more than 70 per cent is contributed by South West monsoon between July to September. The total rainfall during the experimentation was 161.6 mm; maximum and minimum temperature fluctuated between 32.9ºC and 21.3ºC, and relative humidity between 86.5 and 42.2 per cent.

Soil type :

Table 1: Physical and chemical properties of experimental farm soil used.

Soil character	Value
Sand %	50.1
Silt %	37.2
Clay %	12.7
Texture	Sandy loam
Bulk density (mg M ^{3})	1.45
Particle density (mg M ^{3})	2.65
Maximum water holding capacity (%)	30
Field capacity (%)	19.13
Organic matter %	0.27
pH (1 : 2.5 extract)	6.5
Available nitrogen (kg ha ^{1})	177.72
Available P_2O_5 (kg ha ^{1})	9.01
Available K_2O (kg ha ^{1})	113.31
EC (dS m ^{1}) at 25°C	0.29

The soil of the experimental field was sandy clay loam having medium fertility. Soil colour is generally red due to excess of iron. These soils are rich in available nitrogen and potassium but poor in available phosphorus. Before the start of experiment the soil samples were collected with the help of soil auger and core sampler

Experimental design and treatment :

The experiment was conducted in Randomized Block Design with twelve treatments, which were replicated thrice. These treatments were Poultry manure @ 20 kg /tree (T_1), FYM @ 25 kg /tree (T_2), Egg shell (T_3), Paddy straw (T_4), Green manure @ 100 g/tree (T_5), Wheat straw (T_6), Mung straw (T_7), Til straw (T_8), Maize straw (T_9), Removal of weed and spreading (T_{10}), Interculture (T_{11}) and Control (T_{12}). The variety under study was L-49 having 6 years of age with a plant spacing of 7 7 m. Recommended dose of organic nutrients was applied on 9th July, 2010 as per treatments. Organic nutrients applied between the radial distances 100 to 160 cm away from trunk, 3-5 cm deep and then properly covered with soil (Kotur, 2). The field was depending on rainfall during the study period. Ploughing was done to break the dormancy and to keep the soil loose and check weed growth in rows. The guava field was kept weed free by regular manual weeding and also with the help of tractor mounted implements. Plant protection schedule was applied specially for control of fruit fly and mealy bugs by applying 0.1% dichlorvas at monthly interval.

Sampling and measurement:

One plant of each treatment selected, marked, and kept under observations for recording various observations. The height of plant was measured from ground level to the growing tip in meter at one month interval to 180 days of manuring. The stem girth was recorded with help of tape at 25 cm from base and recorded in millimetres. The plant spread was recorded at maximum and minimum spread and then averaged out. The plant volume of selected plants were computed using Westwood (1963) formula :

$$4/3 \quad 0.5 \quad a^2 \quad 0.5 \; b$$

Where,

a = mean spread and

b = plant height in cubic meter.

The fruits harvested from each plant were counted at each harvest. The total number of fruits of all picking were calculated and recorded fruits harvested per plant. The fruits harvested from each observational plant during each harvesting weighed on electronic balance. The total weight of fruit from all harvesting was calculated and recorded as fruit yield per plant in kilogram. Fruit harvested per

Table 2: Effect of nutrient management through organic sources on growth of trees, fruit yield and fruit quality.

Treatment	Growth of trees		Fruit yield		Fruit quality	
	Plant height (cm)	Stem girth (cm)	Fruits per plant	Yield per plant (kg)	TSS (°Brix)	Total sugar (%)
Poultry manure	3.25	291.67	195.0	35.12	12.45	8.67 (2.94)
FYM	3.06	255.33	170.0	32.11	11.51	8.59 (2.93)
Egg shell	2.85	237.00	155.0	29.25	11.40	8.31(2.88)
Paddy straw	2.65	214.67	145.0	26.45	10.51	8.26(2.87)
Green manure	2.35	220.67	140.0	23.63	10.01	7.63 (2.76)
Wheat straw	2.45	207.33	127	24.12	9.68	7.37 (2.71)
Mung straw	2.19	200.67	115.0	21.75	9.41	7.18 (2.67)
Til straw	2.06	180.33	120.0	20.19	9.10	6.06 (2.46)
Maize straw	2.12	196.00	110.0	18.47	8.50	5.95 (2.13)
Removal of weed and spreading	1.98	175.33	87	15.10	8.40	5.45 (2.10)
Interculture	1.91	165.00	84	12.10	8.15	4.95 (2.02)
Control	1.50	144.33	72.0	11.68	7.50	4.55 (1.95)
CD (P=0.05)	0.25	20.94	22.38	4.17	0.29	0.29

·Figures in parentheses are square root transformed values.

plant was in kilogram divided by plant volume and recorded as fruit yield per cubic meter in kilogram. For determining the significance between the treatment means and to draw valid conclusions, statistical analysis was made. Data obtained from various observations were subjected to statistical analysis by adopting appropriate method of "Analysis of Variance". The significance of the treatment effects was judged with the help of F test (Variance ratio).The difference of the treatments mean were tested against critical difference (C D) at 5% probability level when "F' test was significant.

RESULTS AND DISCUSSION

Growth of trees :

The plant height and stem girth were taken as indicators for the growth of guava trees. The maximum values of these parameters were recorded under poultry manure (Table 2) which was at par with FYM and significantly superior over rest of all the treatments. The minimum plant height was recorded under control. It might be due to high nutrient and mineral content present in poultry manure in comparison to other organic sources. These observations were corroborated with the findings of Maji and Das (3) and Villasurda (6).

Fruit yield:

Significantly maximum number of fruits (Table 2) per plant (195) was harvested with the application of poultry manure and minimum number of fruits in control (72). Maximum fruit yield (35.12 kg/plant) recorded with poultry manure was at par with FYM (32.11kg/plant) which was found significantly superior over rest of the treatments. It might be due to high amount of nitrogen in combination with phosphorus and potassium present in poultry manure in comparison to other organic sources enhanced more growth and metabolic transport which leads ultimately the increased fruit yield. In addition to this potassium act as a catalyst in the formation of more complex substances and act as an accelerator of enzymatic activity which were beneficial in early emergence of flower buds and increased fruit set; resulted in fruit retention and increased yield. These observations were in close conformity with the findings of Naik and Babu (4) and Villasurda (6).

Fruit quality:

The data presented in Table 2 indicates that the maximum total soluble solids (12.45°B) recorded in freshly harvested fruits from the trees received with poultry manure followed by FYM. The recorded values of total sugar with poultry manure (8.67%) was at par with FYM (8.59%) found significantly higher to rest of the treatments. The minimum total soluble solids (7.5°B) and total sugar were recorded in untreated control (4.55%). The effect of organic resources on acidity showed non-significant influences. It might be due to high nutrient and mineral content present in poultry manure in comparison to other organic sources confirming to the findings of Katiyar *et al.* (1).

CONCLUSION

On the basis of obtained results it may be concluded that application of various organic sources of nutrients improved growth of trees and increased fruit yield of high quality. This observation was markedly pronounced in the trees applied with poultry manure. Therefore application of the poultry manure for guava trees is highly recommended to enhance growth of the trees and consequently produce high yield of good quality.

REFERENCES

1. Katiyar, P.N., Tripathi, V.K., Sachan, R.K., Singh, J.P. and Chandra, R. (2012). Integrated nutrient management affects the growth, flowering and fruiting of rejuvenated ber. *HortFlora Res. Spectrum,* **1**(1) : 38-41.
2. Kotur, S.C. (2008). Maximizing fertilizer use efficiency in guava. *Indian Hort.,* **38** : 25-28, 2008.
3. Maji, S. and Das, B.C. (2006). Effect of organic and inorganic mulches on vegetative growth and yield of guava cv. L-49. *Env. and Eco.*, **26** (3): 1292-1293.
4. Naik, M. H. and Babu, R. S. H. (2007). Feasibility of organic farming in guava (*Psidium guajava* L.). *Acta Hort.*, **735**:365-372.
5. Ram R.A., Bhriguvanshi, S. R. and Pathak, R. K. (2007). Integrated plant nutrient management in guava cv. Sardar. *Proc. Ist* IS on Guava Eds. *Acta Hort.* **73**(5): 345-350.
6. Villasurda, Baluyut P.J. (1990). Growth and yield of guava (*Psidium guajava* L.) as affected by different levels and sources of organic and inorganic fertilizers, *USM College of Agri. Res. J.,* **1** (1):18-33.
7. Yadav, I. S. (1999). An overview of nutrient management in horticultural crops. *Indian Hort*. **43** (4): 4.

HortFlora Research Spectrum, 1(2): 162-164 (2012) ISSN : 2250-2823

EFFECT OF CYCOCEL ON GROWTH, YIELD AND QUALITY OF TOMATO (*Lycopersicon esculentum* MILL.)

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ABSTRACT: The yield of any crop is influenced by a number of factors. Therefore, an investigation was carried out to determine the effect of different rates of Cycocel on growth, yield and quality of tomato. The findings carried out on tomato, revealed that the application of cycocel at 300 ppm brought about the best results. Cycocel as retardant (CCC) exhibited the capacity for profuse branching, higher leaf count, higher flower cluster and better yield per plant as compared to control.

Keywords : *Tomato, cycocel, growth parameter, yield, quality.*

Tomato belonging to the family Solanaceae is one of the most popular vegetable of the world. But the production and productivity of this crop in India is for below as compared to the global scenario. The quantity being produced is insufficient to feed our burgeoning population. So, it is clear that our tomato production must increased greatly.

Discovery of the chemicals which retard plant growth without such side effects dates back to 1949. Among the new group of quaternary ammonium compounds, the most active compound is (2-chloroethyl trimethyl-ammonium chloride), an analog of choline, in that the hypodryxyl group in choline was replaced by a chlorine substituent. It is named as chlorocholine chloride which was abbreviated as CCC and commercially known as cycocel. This was proved to be most effective chemical as it retarded growth of a larger number of species than any other compound. Many scientists have been trying to control the stem elongation of vegetable plants by the application of growth retarding chemicals, which retard stem elongation and thereby increases green colour of leaves and indirectly affect the flowering and fruiting. Hence, the present experiment was conducted to elucidate the information on the effect of cycocel on growth, yield and quality of tomato cv. Angurlata.

Received : 22.3.2011 *Accepted : 12.4.2012*

MATERIALS AND METHODS

The present investigation was conducted at Research Farm, Department of Horticulture, Allahabad Agricultural Institute Allahabad during winter season. The experiment was laid out in randomized block design with 5 treatments, replicated 4 times. Treatments were cycocel 0 ppm or control, 500ppm, 1000ppm, 2000ppm, and 3000ppm spray. The gross plot size for each treatment was 3.5×1.5m. Tomato plants were planted at a spacing of 60cm×45cm. All the treatments were given in the form of foliar spray at 23 days after transplanting. The plants were sprayed by hand sprayer. The data on the growth parameters were recorded from a sample of three plants taken randomly at different intervals (30 and 50 DAT). Yield and quality aspects were recorded at harvest only and analyzed statistically.

RESULTS AND DISCUSSION

All the concentrations sprayed after twenty three days of transplanting suppressed the growth significantly at thirty and fifty days. The lowest height was recorded at the highest concentration (3000ppm) of cycocel followed by other concentrations i.e. 2000 ppm, 1000 ppm, 500 ppm, respectively. The spread per plant was recorded at two successive stages of growth and the degree of differences caused by different concentrations of CCC was recorded statistically, there was no

Table 1: Effect of different treatments of cycocel on growth parameters of tomato.

S. No.	Treatments	Plant height (cm)		Plant spread (cm)		No. of branches/plant		No. of leaves/plant	
		30 DAT	50 DAT	30 DAT	50 DAT	30 DAT	50 DAT	30 DAT	50 DAT
1.	T_1 (500 ppm cycocel)	31.50	40.74	23.50	38.38	13.50	12.13	29.05	40.30
2.	T_2 (1000 ppm cycocel)	30.54	45.39	24.83	39.24	11.50	14.24	29.85	47.10
3.	T_3 (2000 ppm cycocel)	26.69	41.81	25.25	39.99	13.50	14.75	29.89	47.89
4.	T_4 (3000 ppm cycocel)	27.67	37.97	25.17	40.62	13.67	15.88	30.25	48.25
5.	T_0 (Control No cycocel)	33.95	42.95	21.83	37.02	13.00	14.75	24.45	44.45
	C.D. (P = 0.05)	3.12	4.12	NS	NS	NS	NS	NS	NS

DAT : Days after treatment; NS : Non significant

Table 2 : Effect of different treatments of cycocel on flowering and yield of tomato.

S. No.	Treatments	No. of flower clusters/plant		No. of flowers/cluster		No. of fruits/plant		Total yield of fruits (q/ha)
		30 DAT	50 DAT	30 DAT	50 DAT	30 DAT	50 DAT	
1.	T_1 (500 ppm cycocel)	2.16	11.23	8.99	15.29	9.94	12.98	125.58
2.	T_2 (1000 ppm cycocel)	2.30	11.63	10.50	14.50	10.00	13.00	126.58
3.	T_3 (2000 ppm cycocel)	2.41	12.08	9.42	15.17	10.11	13.13	127.17
4.	T_4 (3000 ppm cycocel)	2.52	12.79	13.83	17.98	10.30	13.50	128.42
5.	T_0 (Control No cycocel)	1.41	10.60	7.33	11.38	9.75	12.83	116.25
	C.D. (P = 0.05)	0.17	4.12	NS	NS	NS	0.056	0.018

DAT : Days after treatment; NS : Non significant

significant differences among the spread of plants of various treatments at various stages of growth. The spread in the control was lowest as compared to all the CCC treated plants (Table 1).

Among the different cycocel treatments, the number of branches and number of leaves per plant were recorded at two successive stages of growth (30 DAT and 50 DAT). There was no significant differences among the treatments at various stages. However, it is evident from the Table 1 that maximum number of branches as well as leaves/plant were recorded on plants which were treated with 3000ppm cycocel. The other treatments also gave more number of branches than control. Thus, it seems that the reduction in terminal growth of the plant paved way to a better lateral growth. These observations are in agreement with the findings of Ali and Siddique (2) and Das and Prusty (4).

The differences in the flower clusters per plant was significant at 30 DAT and 50 DAT. All the treatments of CCC increased the number of flower clusters/plant at different stages (Table 2). Untreated plants produced minimum number of flower clusters/plant. These findings are similar with the report of Weichold (6). Among the number of flowers per cluster, a non-significant difference was noted at 30 and 50 days after treatment. However, 3000 ppm CCC spray produced maximum number of flowers/cluster. Significant differences was found among the treatments as for number of fruits per plant was concerned at 50 DAT only. It is evident from the Table 2 that cycocel 3000ppm gave maximum number of fruits

Table 3 : Effect of different treatment of cycocel on quality of fruits of tomato.

S.No.	Treatments	Volume of fruit (cm^3)	Vitamin C (mg/100g)	TSS (%)	Total titratable acidity (%)
1.	T_1 (500 ppm cycocel)	23.50	29.32	5.00	0.44
2.	T_2 (1000 ppm cycocel)	26.25	28.80	5.25	0.54
3.	T_3 (2000 ppm cycocel)	27.00	27.00	5.48	0.63
4.	T_4 (3000 ppm cycocel)	28.50	25.60	6.00	0.45
5.	T_0 (Control No cycocel)	23.00	31.04	4.50	0.34
	C.D. (P = 0.05)	2.51	NS	NS	NS

DAT : Days after treatment; NS : Non significant

followed by 2000ppm, 1000ppm and 500ppm. Untreated plants gave the minimum number of fruits. Thus, it is apparent that the retardation in the vegetative phase resulted in to increased reproductive phase. These findings are in confirmity with the finding of Abdalls *et al.* (1) and Bhujbal and Patil (3).

The total yield per hectare with treated plots was found to be more than a control plot (Table 2). Cycocel 3000ppm gave maximum fruit yield followed by 2000ppm, 1000ppm and 500ppm. Untreated plants produced minimum yield as compared to treated ones.

Among the different cycocel treatments. (Table 3), the volume of fruit was significantly increased with the increase in the concentration of growth retardant sprayed. Cycocel @ 300ppm gave maximum volume followed by 2000ppm, 1000ppm and 500ppm. Untreated plants produced fruits with lowest volume. Cycocel treatments reduced the vit 'C' content in the fruits at all levels (Table 3). Maximum vit 'C' content was found with the control. However, it was statistically non significant with all the concentration of cycocel sprayed. Total soluble solids (TSS) as well as total tritratable acidity could not be affected significantly with cycocel treatment. However, it was noted that acidity of fruit was increased linearly with every increase in cycocel concentration acidity. Thus, it is clear from the Table 3 that CCC 2000 ppm is optimum level of cycocel as far as total acidity of the fruit is concerned. These findings are in close conformity with the findings of Pandita *et al.* (5).

From the present study application of cycocel recommended as a more effective growth retardant. In this study carried out on Angurlata it was found that the application of cycocel at Cycocel as a growth retardant exhibited the capacity for propuse branching, higher leaf count, higher flower cluster and better yield per plot as compared to control. Thus, it may be concluded that better results can be obtained by the application of 3000 ppm CCC on Angurlata variety of tomato.

REFERENCES

1. Abdalls, A. A. and Verkerk, K. (1971). Growth, flowering and fruiting in tomatoes in relation to temperature, cycocel and G.A. *Northern J. Agri. Sci.*, **18 :** 105-110.
2. Ali, M. H. and Siddique, M. A. (1974). Effect of cycocel on plant size and fruiting response of tomato. *Bangladesh Hort. Sci.,* **2** : 5-10.
3. Bhujbal, B. G. and Patil, A. V. (1973). Preliminary trial with cycocel on some varieities of tomatoes. *Hort. Abstract,* Nov. 1974 (8727).
4. Das, R. C. and Prutsy, S. S. (1972). Effect of growth regulators on growth and yield of garden pea. Abst. 352, A.P., 2273, Vol. 1, No.4
5. Pandita, K. L., Arora, S. K. and Singh, K. (1976). Effect of plant regulators on the chemical, composition of tomato var. H.S. 101. *Haryana J. Hortic. Sci.,* **5** (½) : 65-72.
6. Weichold, R. (1966). Growth retardants also important in forced vegetable growing. *Dtsche gartnb.,* **13** : 203-205.

HortFlora Research Spectrum, 1(2): 165-167 (2012) ISSN : 2250-2823

STANDARDIZATION OF STONE GRAFTING IN SOME MANGO CULTIVARS UNDER LUCKNOW CONDITIONS

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ABSTRACT : The present investigation was carried out during 2005- 2006 at the Horticultural Research Farm of Babasaheb Bhimrao Ambedkar University, Lucknow. The experiment was conducted using six varieties viz. Amrapali, Dashehari, Mallika, Langra, Chausa and Lucknow Safeda in a Randomized Block Design with five replications. Results reflect that the highest success per cent and over all performance of stone grafting operations was recorded by using scion stick cultivar Amrapali, whereas minimum success per cent was in cultivar Lucknow Safeda under Lucknow conditions.

Keywords : *Mangifera indica L., stone grafting, scion woods.*

The mango (*Mangifera indica* L.) is the best known important fruit of the family Anacardiaceae, having excellent taste, flavour and aroma which occupies a prominent place among the fruit crops. It is regarded as the 'King of the fruit' as well as ''National fruit'' of the India. One of the outstanding developments in mango has been the standardization of propagation techniques in different agro-climatic conditions which is reflected in terms of large scale of multiplication of plant using soft wood or stone grafting. It is an easy, cheap and rapid method and has certain advantages over other methods. The soft wood and stone grafted plants grow faster and have early bearing nature. Mukherjee *et al.* (4) first reported the success from India by splice method of grafting. This was further standardized under Delhi conditions and named as Epicotyl grafting. Temperature and humidity appear to be the major limiting factors affecting the success of stone grafting. High rate of transpiration and lower humidity adversely affect the success of grafts (Ram and Sirohi, 7). Therefore, attempts have been made to study the success of stone grafting in some mango cultivars under Lucknow conditions.

MATERIALS AND METHODS

The present investigation was carried out during 2005-2006 at the Horticultural Research Farm of Babasaheb Bhimrao Ambedkar University, Lucknow. The experiment was in a Randomized Block Design with five replications. Scion wood of 4-6 month old, 6-10 cm in length and 0.6 to 0.8 cm thickness (girth) with uniform maturity, containing 4 and 6 well developed vegetative buds and free from any infestation of disease and pests were selected. This type of scion materials were collected from the Residential Campus and Fruit Nursery Farm of Central Institute for Subtropical Horticulture, Rae Bareli Road, Lucknow from healthy and mature trees of standard commercial varieties viz., Amrapali, Dashehari, Langra, Lucknow Safeda, Chausa and Mallika. Stone grafting was performed by employing epicotyle method inside the poly house. In this method, the rootstocks were selected with proper age and thickness of stem and collected from the rural area of the city for stone grafting. Observations were recorded likewise, success per cent of grafting by cumulative numbers of sprouted stone grafts were counted at different stages. Diameter (cm) of rootstock and scion was measured with the help of vernier calipers whereas, sprout length (cm), height of the graft (cm), leaf length (cm) and width (cm) were measured with the help of measuring scale. Number of leaves was counted manually.

RESULTS AND DISCUSSION

The different cultivars had significant effect on success percentage of grafting which was maximum in Amrapali (70%) followed by

Received : 24.1.2012 *Accepted : 27.2.2012*

Table 1: Success of grafting and performance of different scion woods cultivars after 30 and 90 days in stone grafting.

Treatments	Diameter of root-stock (cm)		Diameter of scion (cm)		Sprout length of graft (cm)		Success of grafting (%)
	30 days	90 days	30 days	90 days	30 days	90 days	
T_1 (Amrapali)	5.10	5.29	5.02	5.22	2.11	3.32	70.0
T_2 (Dashehari)	4.71	4.99	4.70	4.95	1.96	2.87	56.0
T_3 (Langra)	5.02	4.98	4.65	4.93	1.85	3.03	50.6
T_4 (Lucknow Safeda)	4.67	4.99	4.94	4.44	1.93	2.52	42.4
T_5 (Chausa)	5.07	4.92	4.81	4.94	1.94	2.54	41.8
T_6 (Mallika)	5.09	4.97	4.94	4.58	1.93	2.57	49.0
C.D. (P = 0.05)		0.303	0.176	0.122	0.142	0.352	0.303

Table 2: Performance of different scion woods cultivars after 30 and 90 days in stone grafting.

Treatments	Height of the grafts (cm)		Number of leaves		Leaf length (cm)	Leaf width (cm)
	30 days	90 days	30 days	90 days	90 days	90 days
T_1 (Amrapali)	19.54	30.68	3.39	7.67	16.17	3.80
T_2 (Dashehari)	18.26	28.69	3.01	5.62	15.95	3.19
T_3 (Langra)	18.91	27.80	2.61	6.34	14.56	2.40
T_4 (Lucknow Safeda)	19.24	28.87	2.75	4.78	15.15	2.82
T_5 (Chausa)	17.86	28.87	2.54	6.12	16.14	2.72
T_6 (Mallika)	16.02	29.50	2.90	6.72	14.34	2.92
C.D. (P = 0.05)	0.742	0.782	0.612	0.721	0.474	0.372

Dashehari (56%) and Langra (50.6%) whereas, minimum was in cultivar Chausa (41.8%). Maximum success in soft wood grafting was obtained in month of June-July in the present study. However, Patil *et al.* (5) obtained maximum success in the month of August and similar results have also been reported by Singh and Srivastava (10). However, Singh and Srivastava (9) found July to be the best period for soft wood grafting. These variations may be due to prevailing condition during the experimentation. It was observed (Table 1) that after 30 to 90 days of grafting, grafts attained maximum diameter of rootstock in cultivar Amrapali (5.10 - 5.29 cm) while, minimum diameter of rootstock in cultivar Lucknow Safeda (4.67-4.99 cm). Diameter of scion after 30 and 90 days of grafting was higher in grafts of cultivar Amrapali (5.02 and 5.22 cm), while it was minimum in cultivar Dashehari (4.70 and 4.95 cm). Hartman and Kestar (1) have also recorded similar results on diameter of scion in mango. Sprout length of grafts was observed maximum in cv. Amrapali (2.11 and 3.32 cm), whereas, the minimum was in cultivar Langra (1.85 and 3.03 cm) after the grafting of 30 and 90 days, respectively. The finding was in close conformity to Lal (3) and Rajan *et al.* (6) on sprout length of grafting in mango.

It is obvious from the Table 2 that the cultivar had significant effect on height of the grafts after 30 and 90 days from grafting. The height of the graft was maximum in Amrapali (19.54 and 30.68 cm) however, it was minimum in cv. Mallika (16.02 cm) and in cv. Langra (27.80 cm) after the grafting of 30 and 90 days, respectively. Sharma and Chauhan (8) studied the effect of different grafting heights in veener grafting of walnut and observed that the grafting at a height of 22.5 cm from the ground level was most successful in comparison to grafting at 15 and 30 cm heights. The higher per cent of

success at 22.5 cm height was attributed to better contact between the cambium of scion and rootstock because the thickness of scion was generally similar of stock at this height. It was observed that the final stage *i.e.,* after 90 days of grafts have significantly higher scion length in cv. Amrapali (16.17 cm) as compared to the rest of the treatments. The influence of the cultivar on number of leaves per graft recorded after 30 and 90 days found significant. The number of leaves at 30 and 90 day graft was significantly maximum in cv. Amrapali (3.39 and 7.67), whereas it was minimum in cultivars Chausa (2.54) and Lucknow Safeda (4.78) after 30 and 90 days of grafting, respectively. It is quite evident from results the (Table 2) that the cultivars had significant effect on the size of leaves on the grafts after 90 days of grafting. Maximum leaf width was also found in cultivar Amrapali (3.80 cm) while it was minimum in cultivar Langra (2.40). Kumari *et al*. (2) also have reported similar results with respect to study.

CONCLUSIONS

The highest success per cent and overall performance of stone grafting operation was recorded by using scion stick cultivar Amrapali, whereas minimum success per cent was in cultivar Lucknow Safeda.

REFERENCES

1. Hartmann, H.T. and Kestar, D.E. (1993). *Plant Propagation*–Principles and Practices. 5th Ed. Prentice Hall of India Pvt. Ltd., New Delhi.
2. Kumari, N. V., Singh, A. K. S., Das, D. K., Ghosh and Dhuryat, T. (2001). Performance of microbudding under different green house structures in *Citrus reticulata* cv. Nagpur mandarin. Changing Scenario in the production system of horticultural crops, Proceeding of National Seminar, Coimbatore, Tamilnadu. *South Indian Hort.,* **49:** 335-337.
3. Lal, B. (1993). Standardization of stone grafting in mango *(Mangifera indica* L.). *Ph.D. Thesis*. C.S.A.U.A.T., Kanpur.
4. Mukherjee, S.K., Majumder, P.K. and Rathore, D.S. (1960). *Ann. Rept.*, I.A.R.I., New Delhi.
5. Patil, J.D., Worke, D.C., Patil, V.K. and Gunjakar, S.N. (1984). Studies on the epicotyl grafting in mango. *Indian J. Hort.,* **41** (1-2): 69-72.
6. Rajan, S. and Singh, A.K. (1991). Effect of solar radiation on the success of stone grafting. Research report presented in group workers meeting on subtropical fruits. APAU, Hyderabad, 18-20 Sept., 1991.
7. Ram, S. and Sirohi, S.C. (1985). Performance of mango cv. Dashehari trees propagated by different vegetative methods. *Second International Symp. on mango.* Banglore. pp 22.
8. Sharma, S.D. and Chauhan, J.S. (1981). Effect of different grafting heights on rootstock in veener grafting of walnut (*Juglans regia* L.) *Prog. Hort.,* **12:** 39-42.
9. Singh, N.P. and Srivastava, R.P. (1981). Studies on the success in stone grafting of mango as influenced by the method of grafting and the age of rootstock. *Punjab Hort. J.,* **21:** 166-71.
10. Singh, N.P. and Srivastava, R.P. (1982). Standardization of factors involved in soft wood grafting in mango. *Prog. Hort.,* **14:** 117-120.

HortFlora Research Spectrum, 1(2): 168-171 (2012) ISSN : 2250-2823

STUDY ON GENETIC VARIABILITY AND HERITABILITY IN *Ocimum spp.*

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ABSTRACT: A field experiment was conducted during *kharif* season of 2008 to study the variability of 25 genotypes of *Ocimum spp.* for 11 traits. The estimate of maximum range and coefficient of variability were noted for six different characters including plant height, leaf length, no. of inflorescence/plant, length of inflorescence, days to maturity and fresh herb yield /plant. The highest estimates of heritability in broad sense were observed for plant height (99.70 %) followed by length of inflorescence /plant (98.80 %), fresh herb yield per plant (98.60%), no. of inflorescence/plant (98.40%), days to maturity (92.60%) and leaf width (91.50%). The highest value of genetic advance was obtained for fresh herbage yield per plant (1018.02) followed by dry herb yield per plant (394.31), no of inflorescence/plant (43.76) and plant height (39.13). Highest values of genotypic and phenotypic covariance indicated wide range of variability and high heritability associated with higher values of relative genetic advance.

Keywords : *Genetic variability, heritability, genetic advance, Ocimum spp.*

The genus *Ocimum* L. (*Lamiaceae*), collectively called basil comprises 30-160 annual and perennial herbs and shrubs native to tropical and subtropical regions of Asia, Africa and Central and South America (Paton, 12). Sweet basil, *Ocimum basillicum* L., is well known for its numerous economical, medicinal and aromatic values (Simon *et al.,* 16) and Morales and Simon, 10). Medicinally, it is useful in a variety of human and animal diseases treatment such malaria, colic, vomiting, common cold, cough and skin diseases (Bhattacharjee, 4). The importance of basil is increasing and has promising future in Egypt, especially, when cultivated in new reclaimed soil under organic agriculture conditions (Abd-El Raouf, 1; and Aboud *et al.,* 2). Genetic improvement in aromatic plants for quantitative characters is helpful for determination of yield components to improve oil yield through selection of genotypes from population (Kazmferezak *et al.,* 8; and Seidkr-Ozykowska *et al.,* 14). Genetic parameters estimating (PCV, GCV, h^2b and GA) are important to determine genetic variability among selected genotypes of different species of basil (De Masi *et al.,* 6; Nurzynska-Wierdak, 11). The objectives of this study were to determine the variation and genetic interrelationships among herb yield components of basil using genetic parameters.

MATERIALS AND METHODS

The present study was carried out during two successive growth seasons of 2008 at the farm of Department of Seed Science and Technology, C.C. S. University, Meerut. 25 *Ocimum* genotypes seeds were selected and sown in bed on 25 March. 35 days old seedlings were transplanted into field on 1st May 2008. All plants were fed by organic manure without any chemical nutrient addition. The plants were harvested 2 times (Cuts) during July and September in both seasons. Data recorded on the 25 genotypes from each replicate in both cuts for 11 characters included: plant height (cm), number of primary branches /plant, number of secondary branches / plant, days to flowering, leaf length (cm), leaf width (cm), number of inflorescence/plant, length of inflorescence (cm), days to maturity, fresh herb yield / plant (g) and dry herb yield / plant (g). A complete randomized block design with three replications was used in the experiment. The general statistical procedures was practiced according to Steel and Torrie (17). Analysis of variance (ANOVA) and broad sense heritability (h^2) were generally assigned for the data

Received : 21.3.2012 *Accepted : 12.4.2012*

of each season according to Robinson *et al.* (13). The phenotypic coefficient of variation (PCV) was computed according to Burton and DeVane (5). The expected genetic advance from selection (GA %) was computed according to Johnson *et al.* (7).

RESULTS AND DISCUSSION

Ocimum species is one of the most important medicinal herbs. A wide range of genetic variability exists in *Ocimum species*. In population, variability plays an important role for making effective selections. The environment plays an important role in determining the phenotypic expression of a particular genotype. Therefore, it is likely that all the genotypes may not express their full potential in a given environment. Hence, it is appropriate to evaluate the genotype at more the one location/ environment to derive conclusive information. In any breeding programme, the skilled knowledge to utilize genetic variability is an important factor. Better and desirable results could be achieved only if a breeder has the thorough knowledge of the material at hand in terms of variability, heritability, expected genetic advance and characters influencing the yield directly or indirectly. This helps proper in construction of selection indices for rapid and desirable improvement. The analysis of variance of the random block design experiment including a total of 25 germplasm accessions in *Ocimum species* were conducted for 11 characters. The mean squares for the different sources of variation are presented in Table 1. The mean squares due to treatment were significant for all the traits. This suggested significant differences among genotypes for all the characters.

The estimates for range and coefficient of variation (%) for the 11 characters on 25 genotypes of *Ocimum* spp. are given in Table 1. In the present investigation, wide range and coefficient of variability were noted for six different characters including plant height, leaf length, no of inflorescence/plant, length of inflorescence, days to maturity and fresh herb yield /plant. This suggested that for these six characters, high variability was available in the 25 *Ocimum* genotypes included in the present study. The variability for the remaining 5 characters including no of primary branches / plant, no of secondary branches / plant, days to flowering, leaf width was moderate. For the remaining only one character dry herb yield /plant showed low variability.

Heritability is an important selection parameter because heritability helps the plant breeder in selection of elite genotypes from genetically diverse population (Table 1). The highest estimates of heritability in broad sense were observed for plant height (99.70 %) followed by length of inflorescence /plant (98.80 %), fresh herb yield per plant (98.60%), no of inflorescence/plant (98.40%), days to maturity (92.60%) and leaf width (91.50%). Moderate heritability estimates were recorded for no. of primary branches / plant (73.20%), no. of secondary branches / plant (68.00 %), leaf length (59.50%) and leaf width (76.70 %). Low heritability estimates were observed only one remaining characters.

Genetic advance is an important selection parameter which helps the plant breeder in selection of elite genotypes from genetically diverse population in (Table 1). The highest value of genetic advance was obtained for fresh herbage yield per plant (99.02) followed by dry herb yield per plant (94.31), no. of inflorescence/plant (43.76) and plant height (39.13). A moderate estimate of genetic advance was observed for length of inflorescence /plant (11.08). In rest of the characters the genetic advance ranged from 0.48 to 5.13%. Thus, these characters may be utilized in further crop improvement programme. It may be possible to improve the fresh herbage yield per plant, seed yield per plant, plant height and dry herbage yield per plant as these characters exhibited high genetic advance. High heritability estimates in broad sense for plant height was also observed by Sharma (15) and Verma *et al.* (18).

Higher values of heritability showed lesser environmental and greater genetic effects. Highest values of genotypic and phenotypic covariance indicated wide range of variability and high

Table 1: Estimates of variability, heritability (h^2) and genetic advance (GA) of 11 quantitative characters in *Ocimum species.*

S. No.	Characters	Mean	Range	PCV	h^2	GA
1.	Plant height (cm)	88.52	63.07-127.73	21.51	99.70	39.13
2.	No. of primary branches per plant	4.42	2.40-6.87	27.19	73.20	1.81
3.	No. of secondary branches per plant	11.31	8.13-14.47	18.94	68.00	3.00
4.	Days to flowering	62.46	58.20-71.47	5.93	59.50	4.54
5.	Leaf length (cm)	4.47	3.00-5.67	13.67	91.50	1.15
6.	Leaf width (cm)	2.45	1.63-2.83	12.46	76.70	0.48
7.	No. of inflourescence per plant	83.12	53.00-130.27	25.97	98.40	43.76
8.	Length of inflourescence (cm)	17.53	7.83-27.27	31.07	98.80	11.08
9.	Days to maturity	119.64	116.80-127.63	2.25	92.60	5.13
10.	Fresh herb yield per plant (g)	2120.13	829.00-3075.00	23.65	98.60	1018.02
11.	Dry herb yield per plant (g)	1110.10	687.33-1744.33	38.35	45.00	394.31

heritability associated with higher values of relative genetic advance. It would employ that additive gene effect were more important and also estimated heritability for important morphological traits. This finding is in accordance with the results of Kirtikar and Basu (9) and Ahmad and Khaliq (3). The characters with high heritability coupled with high genetic advance would respond to selection better than those with high heritability and low genetic advance was suggested by Johnson *et al.* (7). In present investigation the character like fresh herbage yield per plant had high heritability coupled with high genetic advance.

REFERENCES

1. Abd-El Raouf, R.M.S. (2001). Production of sweet basil (*Ocimium basillicum*, L.) in the new reclaimed lands under different levels of biofertilizers and plant densities, *M.Sc. Thesis* Faculty of Agric., Ain Shams Univ., Cairo Egypt.
2. Aboud, K.A., Hussein, R.M. and Ibrahim, M.M. (2006). Genetic improvement for growth and oil yield of selected genotypes of some basil species under different types of organic fertilization. *J. Agric. Sci., Mansoura. Univ.*, **31** (8): 5249 – 5265.
3. Ahmad, S.D. and Khaliq, I (2002). Morpho-molecular variability and heritability in *Ocimum sanctum* genotypes from northern Himalayan region of Pakistan. *Pakistan J. Bio. Sci*. (Pakistan), **5**(10): 1084–1087.
4. Bhattacharjee, S.K. (1998). *A Hand Book of Medicinal Plants.* Pointer Pub. Jaipur, India, 241- 242.
5. Burton, G.A. and DeVane, E.H. (1953). Estimation of heritability in tall Festuca (*Festuca arundinacea*) from replicated clonally material. *Agro. J.,* **45:**478-479.
6. De Masi, L; Siviero, P., Esposito, C., Castaldo, D., Siano, F. and Laratta, B. (2006). Assessment of agronomic, chemical and genetic variability in common basil (*Ocimum basillicum* L.). *Euro. Food Res. Techno.* **223** : 273–281.
7. Johnson, H.W., Robinson, H.F. and Comstock, R.E. (1955). Estimates of genetic and environmental variability in soybean. *Agron. J.*, **49:** 314-318.
8. Kazmferezak, K. and Seidler-Ozykowska, K. (2001). Spice plants breeding in the Research Institute of Medicinal plants (Herbal plants-Cultivation and Universitatis, Mariiae Curie Skodawska Sectia EEE Horticulturea Wydawnictwa Uniwersytettu Marii Curie Skodowsktej,Lubliu,Poland. **9:** 307-310.
9. Kirtikar, K.R. and Basu, B.D. (1984). *Indian Medicinal Plants.* Lalit Mohan Pub. Allahabad, India, 3: 1965-67.
10. Morales, M.R. and Simon J.E. (1996). New basil selections with compact inflorescence for

the ornamental market. In: Janick (ed) Progress in new crops ASHS, Alexandria, pp 543–546.

11. Nurzynska-Wierdak, R. (2007). Evaluation of morphological, developmental variability and essential oil composition of selected basil cultivars. *Herba Polonicia,* **53** (3) 255-261.
12. Paton, A. (1996). Basil Taxonomy, *New Scientist* **9:** 7.
13. Robinson, H.F., Comstock, R.E. and Harvey, P.H. (1951). Genotypic and phenotypic correlation in corn and their implications in selection. *Agron. J.,* **43:** 282-287.
14. Seidkr-Ozykowska, K. and K. Kazmterezak (2001). Selective breeding of sweet basil, (*Ocimium basilciium* L). *Herba Polonica,* **47** (3): 187-190.
15. Sharma, Shailendra (2005). Genetic divergence analysis of some quantitative characters in basil (*Ocimum* species). *M.Sc. Ag. Thesis* submitted to CCS University, Meerut, U.P.
16. Simon, J. E., Quinn, J. and Murray, R. G. (1990). Basil: a source of essential oils. In: *Advances in New Crops*; Janick, J., Simon, J. E., Eds.; Timber Press: Portland, OR, pp 484–489 24.
17. Steel, R.G.D. and Torrie, J.H. (1980). *Principles and Procedures of Statistics*. A Biometrical Approach, McGraw Hill Book Co., New York, USA
18. Verma, P.K., Gupta, S.N., Khabiruddin, M. and Sharma, G.D. (1998). Genetic variability parameters for herb and oil yield in different *Ocimum* species. *Indian Perfumer,* **42** (1): 36-38.

HortFlora Research Spectrum, 1(2): 172-174 (2012) ISSN : 2250-2823

EFFECT OF NITROGEN AND PHOSPHORUS ON CROP GROWTH, HEAD YIELD AND QUALITY OF BROCCOLI (*Brassica oleracea* L. *var. italica*)

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ABSTRACT: An experiment was conducted at Department of Vegetable Science, C.S. Azad Univ. of Agri. & Tech., Kalyanpur, Kanpur during *Rabi* season of 2005-06 to find out the effect of nitrogen (30, 60, 90, 120 kg ha ^{1}), phosphorus (30, 60, 90 kg ha ^{1}) on crop growth, head yield and quality of broccoli. The significant result was obtained in growth and yield parameter, *i.e.,* height of plant, days to central head, head yield per plant and per plot, plant frame, head size, harvest duration and compactness of the head. The most of the characters and optimum head yield of broccoli were favoured by applying 90 kg nitrogen and 90 kg phosphorus per hectare.

Keywords: *Broccoli, nitrogen, phosphorus.*

Broccoli (*Brassica oleracea* L. var. *italica*) belongs to family Cruciferae (*Brassicaceae*). Latin *Brachium* meaning an arm or branch (Choudhury, 1). It contains, iron an calcium and also. It is marketed as fresh, frozen and also used in salads (Peirce, 7). It also have protein 3.3 per cent, thiamine and riboflavin. There are three types of broccoli viz., Green, White, and Purple. Green type is the most nutritive and popular Das (3) because it contains the anticancer property sulphoruphane. Broccoli head resembles cauliflower consisting of clusters of green flower buds. Near to city farmer can fetch more money by cultivating broccoli. The head is harvested along with a few leaves and stem (10-15 cm). Yield of this crop ranges between 5-15 t ha^{-1} depending upon the variety, time of planting and harvesting duration.

MATERIALS AND METHODS

The experiment was conducted at Departmental Farm of Vegetable Science, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during the *rabi* season. Four treatments of nitrogen (30, 60, 90, 120 kg ha ^{1}) and three treatments of phosphorus (30, 60, 90 kg ha ^{1}) with a total of twelve treatment combinations were tested. Farm yard manure @ 20 t ha ^{1} as a common dose in all treatments and entire quantity of phosphorus and one third of nitrogen as per treatment was applied in the form of single super phosphate and urea, respectively before transplanting at the time of field preparation. Remaining nitrogen was given in two splits at 30 and 45 days after transplanting. The trial was laid out in randomized block design with three replications. Total number of treatment combination were 12 with one control and total number of plants / plot were 48. The observations were recorded at appropriate stage of plant.

RESULTS AND DISCUSSION

The present data (Table 1) revealed that the nitrogen levels upto 90 kg ha ^{1} significantly increased plant height. Similarly, with increasing level of phosphorus, the plant height was also increased significantly. Maximum plant height (51.75 cm) was recorded with 90 kgN ha^{-1} over 30 and 60 kg N ha ^{1}. Highest plant height (52.07 cm) was recorded when phosphorus was applied @ 90 kg ha ^{1}. Application of 90 kg ha ^{1} nitrogen and phosphorus separately showed significant responses for days to central head over 30 kg ha ^{1} nitrogen and phosphorus. Findings are supported with Kowalenko and Hall (5) in broccoli and Khurana *et. al.* (4) in cauliflower. The minimum days (58.44) for appearance head was recorded with the 90 kg ha ^{1}. Same level of phosphorus

Received : 18.2.2012 *Accepted : 5.3.2012*

Table 1: Effect of nitrogen and phosphorus on different characters of broccoli.

Treatment	Plant height (cm)	Days to central head	Head yield (q ha^{-1})	Plant frame	Head size (cm^2)	Harvest duration days
(A) Nitrogen levels (kg ha^{-1})						
30	78.71	59.67	136.10	64.26	84.08	36.22
60	50.99	59.11	149.13	67.52	85.88	36.69
90	51.75	58.44	170.15	68.54	90.77	37.56
120	50.47	59.44	159.60	66.38	86.55	36.56
C.D. (P=0.05)	1.11	1.23	5.23	1.26	3.09	0.66
(B) Phosphorus levels (kg ha^{-1})						
30	49.09	60.16	145.97	63.71	80.25	35.50
60	50.27	59.17	154.87	65.65	84.15	36.83
90	52.07	58.17	160.38	70.67	96.04	38.08
C.D. (P=0.05)	0.96	1.07	4.53	1.09	2.68	0.57
(C) Control v/s treatment	46.12	62.67	83.10	58.42	74.38	28.33
C.D. (P=0.05)	1.41	1.57	6.67	1.60	3.94	0.8462

Table 2: Effect of nitrogen and phosphorus on compactness of the head.

Treatment	Number of heads		
	Loose	Medium	Compact
N_1P_1	9	11	10
N_1P_2	8	12	10
N_1P_3	7	12	11
N_2P_1	8	12	10
N_2P_2	10	11	9
N_2P_3	8	12	10
N_3P_1	8	12	10
N_3P_2	6	13	11
N_3P_3	7	10	13
N_4P_1	7	11	12
N_4P_2	9	10	11
N_4P_3	10	11	9
N_0P_0	13	10	7
Average	8.46	11.31	10.23
Total number of heads examined for each treatment = 3X 10 = 30			

No = 0kgN N_1 = 30kgN N_2 = 60kgN N_3 = 90kgN N_4 = 120kgN;

Po = 0kgP P_1 = 30kgP P_2 = 60kgP P_3 = 90kgP

showed minimum days of 58.17. Head yield increased significantly upto level of 90 kgN ha^{1} and higher yield 170.15 q ha^{1} was recorded. In case of phosphorus application, increasing trend was found. Treatment of 90 kg P_2O_5 ha^{1} significantly yielded 160.38 q ha^{1}. Application of nitrogen and phosphorus individually significantly influenced plant frame. Maximum plant spread (68.54 cm) with nitrogen application was noticed at 90 kg ha^{1} which was higher than 60 and 30 kg N ha-1 (Table 1). Maximum plant spread (70.67 cm) was significantly recorded at the treatment of 90 kg

P_2O_5 ha ^{1} over 60 and 30 kg P_2O_5 ha ^{1} where plant spread was 65.65 cm and 63.7 cm, respectively Claypool (2) working with lettuce also observed that nitrogen stimulated vegetative growth and thus giving significant increase in plant size.

As in the case of head size nitrogen application @ 90 kg ha ^{1} produced largest size (90.77 cm^2) which was superior over all the level of nitrogen and higher level of P_2O_5 (90 kg ha ^{1}) was also produced bigger sized head (96 cm^2) over the lower levels of phosphorus. Interaction of nitrogen and phosphorus also influenced the head size significantly confirming to results of Mishra (6) and Sharma and Arora (9) in cauliflower.

The nitrogen and phosphorus applied individually were effective in exerting their impact on harvest duration. Period of availability of produce was increased with 90 kg ha ^{1} level of nitrogen. Phosphorus applied @ 90 kg ha ^{1} gave significant response at harvest duration resulting 38.08 days which was higher over the days 36.83 and 35.50 at the level of 60 and 30 kg P_2O_5 ha^{-1} respectively. In the case of compactness, none of nitrogen and phosphorus either alone or in combination was able to respond effectively (Table 2).

Plant height increased linearly by the application of nitrogen and 90 kg N ha ^{1} produced significantly taller plant than 30 and 60 kg N ha ^{1}. Nitrogen showed its significance in enhancing the plant spread upto 90 kg ha ^{1}.The increase in yield contributing characters like plant spread and head size ultimately affected the head yield and the highest yield / hectare was recorded at 90 kg N ha ^{1}. Harvest duration increased significantly with every increment in level of nitrogen upto 90 kg ha^{-1}. The reduction in the produce availability with increased size of the central heads at this nitrogen rate was also observed. Randhawa and Khurana (8) have also reported non significant impact of this element on curd compactness of cauliflower.

In the case of phosphorus the tallest plants produced by 90 kg P_2O_5 ha ^{1} differ significantly from other levels. No effect on days to central head formation was recorded by phosphorus application. Maximum plant spread by the application of 90 kg P_2O_5 ha ^{1} in comparison to 30 and 60 kg P_2O_5 ha ^{1} might be due to its role in photosynthesis, energy storage, cell division and enlargement (Singh 10). As plant spread and head size were increased by the application of phosphorus upto 90 kg P_2O_5 ha ^{1}, harvest duration was significantly enhanced by the ascending phosphorus levels upto the highest levels (90 kg P_2O_5 ha ^{1}).

REFERENCES

1. Chaudhary , B. (1970). *Vegetables*. 2nd rev. ed. New Delhi National Book Trust. Pp. 78-79
2. Claypool, L.L. (1933). Further studies relative to fertilizer treatment of lettuce *Proc. Am. Soc. Hort. Sci.,* **30 :** 548-549.
3. Das, P.C. (1996). *Vegetable Crops of India*, Kalyani publishers, Delhi P. 53.
4. Khurana, S.C., Singh, G.R. and Pandita , M.L. (1987). A note on nitrogen, phosphorus fertilization and spacing on cauliflower cv. Pusa Synthetic. *Haryana J. Hortic. Sci.,* **16** (3-4) : 298-300.
5. Kowalenko, C.G. and Hall , J.W. (1987). Effects of nitrogen application on direct – seeded broccoli from a single harvest adjusted for maturity. *J. Amer. Soc. Hort. Sci.* **112** (1) ; 9-13.
6. Mishra, I.P (1991). Influence of nitrogen fertilization on development and yield of cauliflower. *JNKVV Res. J.,* **25** (1-4) :3-4.
7. Peirce, Lincoln C. (1987). *Vegetable* : characteristics, production and marketing. John Wiley and Sons. New York pp. 217-219.
8. Randhawa, K.S. and Khurana, D.S. (1983). Effect of nitrogen, phosphorus and potassium fertilization on the yield and quality of cauliflower. *Veg. Sci.,* **10** (1) : 1-7.
9. Sharma, R.P. and Arora, P.N. (1987). Effect of nitrogen on cauliflower. *Veg. Sci.,* **14** (1) :1-6.
10. Singh, S.S. (1996). *Soil fertilizer and nutrient management*. Kalyani Publishers New Delhi, pp.37-38.

HortFlora Research Spectrum, 1(2): 175-177 (2012) ISSN : 2250-2823

Research Note :

STANDARDIZATION OF PLANT MULTIPLICATION IN AONLA (*Emblica officinalis Garten.*) CV. NARENDRA AONLA-6

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ABSTRACT: Field experiment conducted to standardize the optimum stock thickness, budding height and method of budding in aonla cv. N.A. 6 concluded that Narendra Aonla-6 should be budded on 0.5 cm thickness or rootstock at 10 cm height above ground level with patch method of budding during the month of June for higher budding success and further growth of budding.

Keywords: *Aonla, rootstock, budding, bud take, survival.*

Aonla or Indian gooseberry (*Emblica officinalis* Gaertn) is one of the important indigenous minor fruit crops belonging to the family Euphorbiaceae and sub family Phyllanthoidae. It is native to tropical region of South-East Asia particularly Central & Southern India (Morton, 3).

There is lot of demand for aonla grafts particularly cv. NA-6 variety for value addition viz. fruit beverages, sauce, chutney, shreds, jam, *laddu*, toffee, preserves and candy etc. However, the success of budding in this particular cultivar is very poor. This may be because of meagre information available on impact of stock thickness, height and method of budding and growing condition of rootstock as well as season also. Hence, to generate more information about above parameter, a field trial was conducted to assess the positive response of same.

MATERIALS AND METHODS

The investigation was carried out at Main Experimental Station, Department of Horticulture, Narendra Dev University of Agriculture & Technology, Kumarganj, Faizabad (U.P.) during the year 2009. The experiment was laidout in randomized block design (Factorial), replicated thrice considering ten plants as unit with eight treatment combinations viz two thickness of rootstock (T_1= 0.5 cm and T_2 =1.0 cm) along with two different height of buding (H_1 =10 cm and H_2 =20 cm) and two budding method (patch = M_1 and modified ring = M_2) in cv. Narendra Aonla-6. One year old seedling plants of desirable thickness and height grown in nursery bed were taken for budding operation and vigrous pencil thick scion shoots were procured from 15-20 years old trees of aonla cv NA-6. Success of budding viz. per cent bud take, days taken to bud sprouting, per cent bud sprouting, per cent bud survival and growth parameter of budding viz. length of shoot, number of leaves per shoot, diameter of rootstock at union and scion shoot, average number of primary and secondary roots etc. were noted during experimentation.

RESULTS AND DISCUSSION

Observations with regard to success of budding viz. per cent bud take, bud sprouting, bud survival and days taken to bud sprouting were recorded 30 days after budding, however, observations on growth parameters were noted after 120 days of budding. Among the different treatment combinations, the maximum (94.33%) success in respect of budding were noted with patch method on lower girth (0.5 cm) and lower height (10 cm) of budding. Similar results were also reported by Singh *et al.* (8) who reported that on less girth and lower height of budding maximum success (94.74%) was obtained in ber. As for method is concern Saroj *et al.* (6) achieved more than 90% success through patch budding.

Study related to days taken to bud sprouting showed that patch budding took minimum days to

Received : 3.3.2012 *Accepted : 22.3.2012*

Table 1: Impact of method, stock thickness and height of budding on budding success.

Treatment	Per cent bud take	Days taken to bud sprout	Per cent bud sprouting	Per cent bud survival
$M_1T_1H_1$	94.33 (76.27)	18.67	89.33 (79.95)	92.33 (73.95)
$M_1T_1H_2$	75.00 (60.36)	19.33	70.00 (57.30)	73.00 (59.00)
$M_1T_2H_1$	86.33 (68.34)	17.67	81.33 (64.42)	84.33 (66.71)
$M_1T_2H_2$	72.33 (58.99)	16.33	67.33 (55.16)	70.33 (52.02)
$M_2T_1H_1$	86.00 (68.34)	19.33	81.00 (64.34)	84.00 (66.67)
$M_2T_1H_2$	61.67 (51.75)	20.39	56.67 (48.83)	59.67 (50.58)
$M_2T_2H_1$	63.00 (52.54)	19.00	58.00 (49.61)	61.00 (51.36)
$M_2T_2H_2$	75.67 (60.46)	18.67	70.67 (57.22)	73.67 (59.14)
C.D. (P = 0.05)	6.57	N.S.	6.0	6.34

Table 2: Impact of method, stock thickness and height of budding on growth parameters of budlings.

Treatment	Length of shoot (cm)	Number of leaves per shoot	Diameter of root stock (cm)	Diameter of scion stock (cm)	Number of primary root	Number of secondary root	Fresh weight of shoot (g)	Dry weight of shoot (g)	Fresh weight of root (g)	Dry weight of root (g)
$M_1T_1H_1$	33.96	34.91	1.12	0.73	25.39	15.30	51.35	23.54	41.35	19.70
$M_1T_1H_2$	27.00	27.76	0.89	0.58	20.19	12.17	40.82	18.72	32.28	15.67
$M_1T_2H_1$	31.08	31.95	1.03	0.68	23.28	14.03	47.07	21.59	37.92	18.07
$M_1T_2H_2$	26.04	26.77	0.86	0.57	19.51	11.76	39.45	18.09	31.78	15.14
$M_2T_1H_1$	30.96	31.83	1.02	0.67	23.13	13.94	46.76	21.45	37.67	17.95
$M_2T_1H_2$	22.20	22.82	0.73	0.48	16.67	9.99	33.51	15.37	26.99	12.86
$M^2T_2H_1$	22.68	23.30	0.75	0.49	16.87	10.17	34.12	15.65	27.49	13.10
$M_2T_2H_2$	27.24	28.01	0.90	0.59	20.42	12.30	41.28	18.93	33.25	15.84
C.D. (P=0.05)	3.40	3.49	0.10	0.04	2.43	1.27	4.91	2.25	3.95	1.88

bud sprouting in comparision to modified ring budding. Per cent bud sprouting results enunciate that patch budding on less thickness and lower height have higher bud sprouting. Nosal and Gonkiewicz (4) reported that higher height reduced the length of sprout and per cent bud sprouting also decline. Saroj *et al.* (6) found that girth of rootstock matrix should not be less than 0.5 cm during budding for better success. Per cent bud survival also followed the same trend and patch budding on lower girth and lower height achieved highest success in final survival of bud. Similar results were also reported by Pathak *et al.* (5) who achieved more success and bud survival per cent by patch budding than modified ring budding. Scibisz (7) recommended that budding at lower height resulted in more growth than higher height and Singh *et al.* (8) advocated that less thickness (0.5cm) in comparison to more thickness (0.75 cm) gives maximum success.

The reason of maximum success with treatment combination of patch budding on lower thickness (0.5cm) and lower height (10 cm) might be due to the fact that mortality rate of bud was low because of better interlocking of cambium in patch budding particularly on lower thickness where easy and uniform union takes place and in addition to this lower height enhance the sprouting and survival of bud, being nearer to ground.

Perusal of Table 1 clearly indicated that maximum length of shoot was recorded in combination of patch budding on lower thickness and lower height. Former workers have also

reported that shoot length decreases with increasing the budding height.

The number of leaves per shoot was also maximum with patch budding on less girth and lower height. Diameter of rootstock at union and diameter of scion was also maximum with patch budding on less girth and lower diameter. This may be due to early sprouting and better union noticed in this combination which may enable more diameter of rootstock at union. Similar findings were also reported by Kviklys and Lanauskas (2) who reported that total shoot growth and stem diameter were reduced when budding performed at higher height in comparison to lower height. Average number of primary and secondary roots were more (25.39 and 15.30, respectively) with patch budding on lower thickness and less height. Fresh weight of shoot and root were recorded higher in patch budding on lower thickness and lower height in comparison to others. Singh (9) also reported that patch budding attains maximum fresh weight of shoot and root than other budding methods.

However, dry weight of shoot and root followed same trend as in case of fresh weight of shoot and root. The maximum dry weight of shoot and root were found with patch method of budding (20.48 g and 17.14g, respectively) Similar results were reported by Bhatnagar (1) who concluded that the dry matter production of both shoot and root portion showed direct correlation with height and growth of *Casurina* plant.

REFERENCES

1. Bhatnagar, H.P. (1962). Preliminary studies on nutritional requirement of casurina seedlings. *Indian J. Forestry,* **23:**121-126.
2. Kviklys, D. and Lanauskas, J. (2007). Effect of budding height and rootstock on the quality of apple planting material. *Acta Hort.,* **732**, 141-144.
3. Morton, J.F. (1960). The emblic (*Phyllanthus emblica* L.) *Eco. Bot.,* **14**:119-127.
4. Nosal, K. and Gonkiewicz, A. (2000). Effect of budding height on growth and yield of 'Sampion' apple trees on P-14 rootstock after planting. *Zeszty Naukowe Instytutu Sodownictwa Kwiaciarstwa W Skierniewicach,* **8**:117-121.
5. Pathak, R.K., Ojha, C.M., Dwivedi, R. and Hari Om (1991). Studies on the effect of methods and duration of budding in aonla. *Indian J. Hort.*, **48 (3)**: 207-212.
6. Saroj, P.L., Vishal Nath and Vashishtha, B.B. (2000). Effect of Polycontainers on germination, seedling vigour, root characters and budding success in aonla. *Indian J. Hort*., **57 (4):**300-304.
7. Scibisz, K. (1999). Effect of rootstock and height of budding on growth and yield of 'Sawa' apple trees at different soil management. *Proc. Inter. Seminar,* Deptt. of Pomology, Warsaw Agric. Univ. 111-112.
8. Singh, K., Singhrot, R.S. and Chauhan, K.S. (1981). Effect of budding height and diameter of rootstock on budding success and budling growth of ber. *Haryana J. Hortic. Sci.,* **10:**69-71.
9. Singh, V.K. (1999). Studies on vegetative propagation of Jamun (*Syzygium cumini Skeels*). *M.Sc. (Ag.) Thesis,* N.D.U.A. &T. Faizabad (India).

HortFlora Research Spectrum, 1(2): 178-180 (2012) ISSN : 2250-2823

Research Note :

RUSSIAN OLIVE (*Elaeagnus angustifolia* L.): PROBABLE ORNAMENTAL PLANT FOR BIO-AESTHETIC LANDSCAPING IN COLD ARID ECOSYSTEM

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Keywords: *Ladakh, high altitude, Elaeagnus angustifolia, aesthetic gardening,*

Ladakh is a cold arid desert region of India, characterized by freezing winters and scorching summers with high solar intensity and meager annual precipitation. The region lies between 32°-36°N latitude and 76°-79°E longitude with an area of 97,782 km^2. The region is believed to be one of the coldest region and driest place on the earth. Because of these peculiar features, the region possesses scarce vegetation with most of the area looking fade and barren. The people of Ladakh tend to strive hard for their sustenance with the efficient utilization of many of the plant species existing in the region with their unique management through their indigenous knowledge for fulfilling their domestic requirements (Both, 1; Singh, 6). The fast growing populations, ever increasing human needs and depletion of the natural resource has necessitated initiation of scientific management of natural resources in the region. Besides this, Reeve *et al*. (4) describes that "Plants in cities have a humanizing effect". They enhance the general quality of the environment and also indirectly contribute to an increase in the value of other components of the environment, of buildings for example. The appropriate use of plants increases the quality of the environment up to 30% (Reeve *et al.* 4). For plants to be considered as ornamental, they may require specific work and activity by a gardener. Most commonly ornamental garden plants are grown for the display of aesthetic features including: flowers, leaves, scent, overall foliage texture, fruit, stem and bark, and aesthetic form. Natives in Ladakh have zest for establishment, development and beautification of their surroundings (Fig. 1&2) for their own satisfaction *vis-a-vis* attracting the tourists, which is the major contributing industry to the economy of the region. It is estimated that only Leh district receives around 60 to 80 thousand tourists annually (*leh.nic.in*) and in 2011 it crossed 1.5 Lakh. For the same, they are testing varying annuals, biennials and perennial plant species either available to them locally or brought from Kashmir valley, Himachal Pradesh or other nearby parts of the country. In this process, the people of the region have amazingly selected and successfully established many ornamental plant species for their home gardens and surrounding landscape. The present article deals with identification and selection of the ornamental characteristics of Russian Olive (*Elaeagnus angustifolia*) which is found growing successfully in the region and its probable aesthetic utilization for beautifying the cold arid landscape. For the characteristic brown red colour and excellent finish of its wood, the species is used for making pillars in of traditional houses and furniture. Leaves and twigs are lopped and fed to domestic animals during winters when there is dearth of fodder. Fruits are edible.However, in Leh, its fruits do not mature due to shorter growing season. Being actinorhizal in nature, the plant also fixes atmospheric nitrogen (Raj *et. al.,* 3).

Ornamental characterization of Russian Olive (*Elaeagnus angustifolia*) :

Texture, form, size and colour are the physical characteristics of plants that provide interest,

Received : 14.1.2012 *Accepted : 6.2.2012*

variety and aesthetic appeal to a landscape. Besides being essential to life on our planet, plants add beauty and charm with their unique forms and colour. The basic criteria involved in physical characterization which details the plants distinct look and personality. Ornamental plants and trees are distinguished from utilitarian and crop plants, such as those used for agriculture and vegetable crops, and for forestry or as fruit trees. This does not preclude any particular type of plant being grown both for ornamental qualities in the garden, and for utilitarian purposes in other settings. Some plants are extroverts/loud, boisterous and energetic attention getters, while others are introverts/quiet, calm, and content to be in the background. Tanguy and Tanguy (7) distinguished between an "objective plant" and a "subjective plant": objective plants consist of their physical characteristics (habit, shape, leaf size etc.), while subjective plants are made up from the observer's interpretation of the objective plant. Many plants have strong associative and symbolic meanings, for individuals as well as for large groups of people, and in culture, generally speaking. A good mix of plant personalities creates an interesting and appealing garden. The cold arid desert plants have not till date been utilized for landscaping to their fullest potential. The phenotypic characters of the plant and their interaction with the environment and its various biotic and abiotic components was documented. Russian olive has not yet received attention by floriculturists and landscape architects, so unexposed as ornamental till date. A survey conducted mainly in Leh city and its surrounding nearby villages regarding the various aspects of probability of the use as ornamental was done as per its visual appearance/features and place in the home gardens.

Fig. 1: Young Specimen Plant.

Fig. 2: Flowers of *Elaeagnus.*

Description of Russian Olive:

Elaeagnus angustifolia is widely grown across southern and central Europe as an ornamental plant: for its scented flowers, edible fruits, and attractive silver foliage and black skin. *Elaeagnus angustifolia* L. (Syn: *Elaeagnus hortensis* Bieb.) is a small Eurasian tree with dark brown branches bearing silvery young shoots. Fruits are dry and ellipsoid to oblong in shape with thick stony endocarp. The species is distributed from Spain in west to China in the east through western and central Asia (Hooker, 2). In India, the species is found in Ladakh, the Western Trans-Himalayan region of the country. *Elaeagnus angustifolia* is usually a thorny shrub or small tree growing to 5–7 m in height. Its stems, buds, and leaves have a dense covering of silvery to rusty scales (Fig.1). The leaves are alternate, lanceolate, 4–9 cm long and 1-2.5 cm broad, with a smooth margin. The highly aromatic flowers, produced in clusters of 1-3, are 1 cm long with a four-lobed

creamy yellow corolla (Fig. 2), they appear in early summer and are followed by clusters of fruit, a small cherry-like drupe 1-1.7 cm long, orange-red covered in silvery scales. The fruits are edible and sweet, though with a dryish, mealy texture.

Robinson (5) writes that every human being responds in a personal way to individual plants. Therefore, subjective responses to plants can be separated from their objective qualities, which all observers can with certainly be expected to perceive. Each plant needs to be considered individually when selecting plants for a composition, but the entire composition takes on greater importance than the individual plants. For this reason, it is important to describe how the characteristics of each plant will relate to the plant or landscape next to it.

Aesthetic Description of Russian Olive (*Elaeagnus angustifolia* L.)

Common name: Russian olive
Botanical name: *Elaeagnus angustifolia*
Local name: Sersang
Habit and Habitat: A multi-stem tree growing on high altitudes preferring moist soil.
Mature tree size: 15-25 feet
Water requirement: Moderate (optimum soil moisture availability during active growth period)
Growth rate: Moderate
Form: Pyramid long and upright
Attract wildlife: Yes
Flower colour: Yellow/ light yellow
Flowering season: Late spring
Foliage colour: Silvery green
Fall colour: Slight silvery to fade dusty green
Pest/Disease: No serious disease/pest
Propagation: Seeds, cuttings and suckers
Other features: Small attractive scented flowers, attractive dark brown multi-stem. Dense shade tree and easily propagable, bears edible fruits and fixes atmospheric nitrogen.
Landscape value: Excellent as a specimen plant in home gardens; naturalized with native ornamentals to attract wildlife during flowering. Besides it can be utilized as a roadside avenue or for boundary plantation. It can prove as an excellent wind breaker. Hedging can be done with Russian olive if pruned and trained properly.

CONCLUSION

Russian olive is a unique plant in terms of its growth, branching pattern, silvery foliage, scented flowers and all together a unique contrast when compared with some common plants. Its mode of easy propagation, dense foliage, responsive to pruning and excellent multi-stemmed growth can prove its ornamentality for a landscape. The present paper defines Russian Olive as an ornamental plant and provides a bird eye view to the Landscapists, Naturalists, Floriculturists and all the related individuals and organizations to further explore its aesthetic value. There is no sufficient evidence in literature regarding the ornamental use of Elaeagnus in India so far. Preliminary investigation is considered helpful in further selection and evaluation of various ornamental parameters to expand its value and potential.

REFERENCES

1. Both, N.K. (1983). *Basic Elements of Landscape Architecture* Design. Elsevier, New York, Amsterdam, Oxford, 315 p.
2. Hooker, J.D. (1890). *The Flora of British India*. Vol. V. London.
3. Raj, A., Mehdi, M., Sharma, O.C. and Sharma, P.K. (2010). Five fruit morphotypes of Russian olive (*Elaeagnus angustifolia* L.) from Ladakh, India. *Plant Genetic Resources: Characterization and Utilization*, **8**(2): 159–161
4. Reeve, L., Relf, P.D. and Lohr, V.I. (2003). Human issues in horticulture. *HortSci.*, **38**(5): 984-993.
5. Robinson, N. (1992). *The Planting Design*. Grower Publishing Company Limited, Hampshire.
6. Singh, A. K. (2009). Probable Agricultural Biodiversity Heritage Sites in India: I. The Cold-Arid Region of Ladakh and Adjacent Areas. *Asian Agri-History,* **13** (2): 83–100
7. Tanguy, F. and Tanguy, M. (1985). *Landscape Gardening and the Choice of Plants*. University Press of Virginia, 85 p.

HortFlora Research Spectrum, 1(2): 181-183 (2012) ISSN : 2250-2823

Research Note :

GROWTH AND SEED YIELD OF FENNEL AS INFLUENCED BY *RHIZOBACTERIA*

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Keywords: *Fennel, Rhizobacteria, growth and seed yield.*

Fennel (*Foeniculum vulgare*) is one of the most important seed spices grown in north India and widely cultivated mainly for its seeds. It grows well under dry and cold weather conditions and therefore its cultivation spread from Gujarat onwards to the northern parts of India. It is used for culinary preparations due to changed food habits and as a constituent in medicinal preparations of various systems of medicines. Fennel seeds are aromatic, stimulant and carminative, which are used in diseases like cholera, bile and nervous disorders. The productivity of a crop is controlled by many factors of which the mineral nutrition especially of nitrogen is by and large the most important factor but the heavy and imbalanced use of chemical fertilizers had led to deterioration in soil health to a great extent. No single source of nutrient is capable of supplying plant nutrients in adequate amount and balanced proportion. Therefore, to maintain soil fertility and to supply plant nutrients in balanced proportion for optimum growth and yield of fennel in an integrated manner in a specific agro-ecological situation is to practice integrated nutrient supply system through the combined use of organic, biological and chemical sources of plant nutrients. Keeping this in view, the present investigation was undertaken to evaluate the beneficial effect of two different strains of *Rhizobacteria* (FK 14 and FL 18) alone as well as their combinations by seed treatment and soil application along with *Trichoderma* (MTCC-5179) on growth and seed yield of fennel.

The experiment was carried out at Vegetable Research Farm of CCS Haryana Agricultural University, Hisar during the *rabi* season of 2008-09 and 2009-10. The soil of experimental plot was sandy loam with pH 8.4, organic carbon 0.35%, available nitrogen 128 kg, available P_2O_5 30 kg/ha and available K_2O_4 94 kg/ha. The treatments consist of two different strains of *Rhizobacteria* (FK 14 and FL 18) alone as well as their combinations by seed treatment and soil application along with *Trichoderma* (MTCC 5179) in fennel cv. Hisar Swarup (HF-33).The experiment comprised of a set of eight treatments-T_1-*Rhizobacteria* FK 14 (Seed treatment),T_2-*Rhizobacteria* FK 14 (Seed treatment + Soil application), T_3-*Rhizobacteria* FL 18 (Seed treatment), T_4-*Rhizobacteria* FL 18 (Seed treatment + Soil application),T_5-*Rhizobacteria* FK 14+FL 18 (Seed treatment),T_6-*Rhizobacteria* FK 14+FL 18 (Seed + Soil treatment), T_7-*Trichoderma* MTCC 5179 (Recommended dose) and T_8-Control,was laid out in randomized block design with three replications. Irrigation and other intercultural practices were done as per general recommendation. The recommended dose of inorganic nitrogen @ 50kg/ha was applied. A uniform basal dose of 25 kg P_2O_5/ha along with one third quantity of nitrogen was given at sowing time and remaining two third of nitrogen was top dressed and incorporated in soil after 30 and 60 days after sowing. The fennel seeds were treated with *Rhizobacteria* strains @ 10g/kg of seed and soil application of *Rhizobacteria* and *Trichoderma* (MTCC 5179) @ 50g/sqm area was done as per treatment just before sowing. Seed of fennel cv. Hisar Swarup (HF-33) were sown at spacing of 20 cm in plant to plant and 30 cm row to row apart during last week of October. The experimental plot size was 4.0 x 2.4 m. All the recommended cultural practices and protection measures were followed throughout the experimentation.

Received : 21.3.2012 *Accepted : 11.4.2012*

Table 1: Effect of *Rhizobacteria* on growth and seed yield of fennel (Pooled data of 2008-09 and 2009-10).

S.No.	Treatments	Plant height (cm)	Branches per plant	Umbels per plant	Umbellets per umbel	Seeds per umbel	Seed yield (kg/ha)
1.	T_1-*Rhizobacteria* FK 14 (Seed treatment)	163.9	11.6	66.6	31.6	731.7	1952
2.	T_2-*Rhizobacteria* FK 14 (Seed treatment + Soil appl)	155.4	11.7	58.1	30.5	630.1	1513
3.	T_3-*Rhizobacteria* FL 18 (Seed treatment)	158.6	11.7	61.9	30.5	617.7	1562
4.	T_4-*Rhizobacteria* FL 18 (Seed treatment + Soil appl)	160.1	11.9	64.3	32.3	818.3	1914
5.	T_5-*Rhizobacteria* FK 14+FL 18 (Seed treatment)	154.7	11.7	67.0	30.2	597.6	1737
6.	T_6-*Rhizobacteria* FK 14+FL 18 (Seed + Soil treatment)	153.0	11.6	67.9	31.3	580.5	1637
7.	T_7-Trichoderma MTCC 5179 (*Recommended* dose)	159.7	11.3	72.0	30.5	626.4	1964
8.	T_8-Control	151.4	11.1	61.9	28.9	566.1	1466
C.D. (P = 0.05)		11.2	0.5	6.7	1.7	43.1	115

Application of *Trichoderma* MTCC (5179), being at par with *Rhizobacteria* FK 14 (Seed treatment) and *Rhizobacteria* FL-18 (seed treatment + soil application) significantly increased the plant height, umbel per plant and seeds per umbel over the control. Maximum plant height (163.9) was recorded with the application of *Rhizobacteria* FK 14 (Seed treatment) followed by *Rhizobacteria* FL-18 (seed treatment + soil application). Maximum branches per plant (11.9) was recorded in *Rhizobacteria* FL-18 (seed treatment + soil application). However maximum umbellet per umbel (72) was recorded in *Trichoderma* MTCC (5179). Maximum seeds per umbel (818.3) recorded in *Rhizobacteria* FL-18 (seed treatment + soil application) followed by *Rhizobacteria* FK 14 (Seed treatment i.e.731.7. The results are in conformity with the findings of Vessey (3).

Data further showed that seed yield of fennel (Table 1) was significantly and favourably influenced with the use of *Trichoderma* (MTCC 5179) and different strains of *Rhizobacteria* (FK 14 and FL 18) alone as well as their combinations by seed treatment and soil application.

The maximum seed yield (1964 kg/ha) was recorded with the application of *Trichoderma* MTCC- 5179 remained at par with *Rhizobacteria* FL-14(seed treatment) and *Rhizobacteria* FL-18 (seed treatment + soil application) yielding 1952 kg/ha and 1914 Kg/ha, respectively. Fennel seed yield is an output of sequential metamorphosis from store to sink. Partitioning of photosynthates in vegetative and reproductive parts goes simultaneously in the later growth phases. The combined effect of inorganic N and *Rhizobacteria* played very important role due to their synergistic effect. Application of *Rhizobacteria* increased the supply of easily unavailable nutrients in to available form. Moreover, *Rhizobacteria* also perform better when soil is well supplied with nutrients particularly nitrogen. The results confirm the findings of Kachot *et.al.* (1), Ramesh *et.al.* (2) and Vessery (3).

Thus, by concidering the favourable effect of *Rhizobacteria* on the succeeding crop as well as soil health, application of *Trichoderma* MTCC-5179 or *Rhizobacteria* FL-14 (seed treatment) could be recommended for cultivation of Fennel for obtaining higher seed yield.

REFERENCES

1. Kachot, N.A., Malavia, D.D., Solanki, R.M. and Sagarka, B.K. (2001). Integrated nutrient management in rainy-season groundnut (*Arachis hypogaea*). *Indian J. Agro.,* **46**(3) : 516-522.
2. Ramesh, R., Shanthamullaiah, N.R., Jayadeva, H.H. and Hiremath, R.R. (1997). Growth and yield of irrigated groundnut as influenced by phosphorus, farmyard manure and phosphate solubilizing micro-organisms. *Current Res*., **26**(1) : 196-190.
3. Vessey J.K. 2003. Plant growth promoting *Rhizobacteria* as biofertilizers. *Plant and Soil*, **255:** 571-586.

HortFlora Research Spectrum, 1(2): 184-186 (2012) ISSN : 2250-2823

Research Note :

EVALUATION OF TARO (*Colocasia esculenta var. antiquorum*) GENOTYPES AGAINST LEAF BLIGHT (*Phytophthora colocasiae*) UNDER EASTERN UTTAR PRADESH CONDITION

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Keywords: *Colocasia, phytophthora blight, susceptibility.*

Taro (*Colocasia esculenta var. antiquorum*) is one of the major root crops in India as well as world and is an important source of food and income. Corms are high in carbohydrates and the leaves are an excellent source of vitamins. In addition to its nutritional and economic importance, taro plays a significant role in the cultural heritage of the different parts of India, and is considered an essential component of many traditional ceremonies. Marian Raciborski (1900) first described *Phytophthora colocasiae* causing leaf blight of Taro in 1900 from Java. The pathogen probably spread from Java to the North Pacific; from Java to the Central Pacific; and from Java to the South Pacific (Trujillo, 12). It was first reported from India in 1911 (Butler and Kulkarni, 3). It is the most destructive fungal disease responsible for heavy yield losses (25 to 50%) of taro in India (Misra, 5; Grade and Joshi, 2). In addition, this pathogen causes a serious post- harvest decay of taro corms. Some fungicides can be used but are generally too expensive for the majority of growers. Breeding plants with resistance to the disease offers the best long-term strategy for the management of the disease.

Ninety genotypes of taro were planted at Main Experiment Station of Vegetable Science Department, NDUAT Kumarganj Faizabad, Uttar Pradesh during *Kharif* 2006 and 2007. The experiments were conducted in augmented design. All the recommended package and practices were followed for raising a good crop except plant protection. The disease was scored on 0-5 scale (Prasad, 7). Disease incidence was determined by given formula :

$$\text{Disease incidence} = \frac{\text{Infected plants}}{\text{Total plants}} \quad 100$$

The use of resistant genotypes is considered to be the best method for disease management. Therefore, the present study was carried out to determine source of resistance against *P. colocasiae*. Ninety taro genotypes were evaluated under natural epiphytotic conditions during *Kharif* 2006 and 2007 cropping season. Out of the ninety genotypes evaluated none was found highly resistant, resistant and moderately resistant. Only seven genotypes were recorded moderately susceptible namely NDC-1, NDC-2, NDC-3, PKS-1, NDC-61, NDC 68 and NDC-84. Twenty three genotypes viz., NDC-4, NDC-5, NDC-7, NDC-8, NDC-9, ND-10, NDC-11, NDC-13, NDC-14, NDC-15, NDC-16, NDC-17, NDC-18, NDC-19, NDC-25, NDC-27, NDC-28, NDC-29, NDC-31, NDC-37, NDC-41, NDC-43, and NDC-44 gave susceptible reaction. Sixty genotypes viz., NDC-6, NDC-12, NDC-20, NDC-21, NDC-22, NDC-23, NDC-24, NDC-26, NDC-30, NDC-32, NDC-33, NDC-34, NDC-35, NDC-36, NDC-38, NDC-39, NDC-40, NDC-42, NDC-45, NDC-46, NDC-47, NDC-48, NDC-49, NDC-50,

Received : 5.3.2012 *Accepted : 27.3.2012*

Table 1: Performance of Taro (*Colocasia esculenta var. antiquorum*) genotypes against leaf blight (*Phytophthora colocasiae*) under Eastern Uttar Pradesh condition during *Kharif* 2006 and 2007.

S.No.	Scale	Range of DI (%)	Reaction	No. of genotypes	Name of genotypes
1.	0	0.00	HR	Nil	Nil
2.	1	1-5	R	Nil	Nil
3.	2	6-25	MR	Nil	Nil
4.	3	26-50	MS	7	NDC-1, NDC-2, NDC-3, PKS-1, NDC-61, NDC-68, NDC-84,
5.	4	51-75	S	23	NDC-4, NDC-5, NDC-7, NDC-8, NDC-9, NDC-10, NDC-11, NDC-13, NDC-14, NDC-15, NDC-16, NDC-17, NDC-18, NDC-19, NDC-25, NDC-27, NDC-28, NDC-29, NDC-31, NDC-37, NDC-41, NDC-43, NDC-44,
6.	5	76-100	HS	60	NDC-6, NDC-12, NDC-20, NDC-21, NDC-22, NDC-23, NDC-24, NDC-26, NDC-30, NDC-32, NDC-33, NDC-34, NDC-35, NDC-36, NDC-38, NDC-39, NDC-40, NDC-42, NDC-45, NDC-46, NDC-47, NDC-48, NDC-49, NDC-50, NDC-51, NDC-52, NDC-53, NDC-54, NDC-55, NDC-56, NDC-57, NDC-58, NDC-59, NDC-62, NDC-63, NDC-64, NDC-65, NDC-66, NDC-67, NDC-69, NDC-70, NDC-71, NDC-72, NDC-73, NDC-74, NDC-75, NDC-76, NDC-77, NDC-78, NDC-79, NDC-80, NDC-81, NDC-82, NDC-83, NDC-85, NDC-86, NDC-87, NDC-88, NDC-89, NDC-90

DI = Disease incidence; HR = Highly resistant; R = Resistant; MR = Moderately resistant; MS = Moderately susceptible; S = Susceptible and HS = Highly susceptible.

NDC-51, NDC-52, NDC-53, NDC-54, NDC-55, NDC-56, NDC-57, NDC-58, NDC-59, NDC-62, NDC-63, NDC-64, NDC-65, NDC-66, NDC-67, NDC-69, NDC-70, NDC-71, NDC-72, NDC-73, NDC-74, NDC-75, NDC-76, NDC-77, NDC-78, NDC-79, NDC-80, NDC-81, NDC-82, NDC-83, NDC-85, NDC-86, NDC-87, NDC-88, NDC-89 and NDC-90 were recorded highly susceptible against *Phytophthora* leaf blight of taro during both the years.

These present findings are in accordance with the reports of earlier workers Goswami *et al.,* 1; Misra, 4; Okpul *et al.,* 6; Shukla, 8; Singh *et al.,* 9 and Thankappan, 11. Yadav *et al.,* 8 studied the coefficient of infection (per cent disease infection as well as per cent disease severity). Out of 34 genotypes evaluated, three were found to be highly resistant, twelve resistant, nine moderately resistant, three moderately susceptible, two susceptible and five highly susceptible against leaf blight disease. Sugha and Gurung (10) made similar studies and reported that none of the genotypes evaluated were free from disease. However, thirteen lines were found to be susceptible, forty seven moderately susceptible and two lines highly susceptible against taro blight. Yadav and Aggarwal (14) reported fourteen resistant, thirty three moderately resistant, forty two moderately susceptible and twelve susceptible genotypes against leaf blight of colocasia.

REFERENCES

1. Goswami, B.K., Zahid, M.I. and HAG-MO (1993). Screening of *Colocasia esculenta* (L.)

germplasms to *Phytophthora* leaf blight. *Bangladesh J. Pl. Patho.,* **9**(1-2):21-24.

2. Grade, U.A. and Joshi, M.S. (2003). Influence of weather factors on the incidence of leaf blight of colocasia. *Ann. Pl. Prot. Sci.*, **11** (1): 168-170.
3. Butler, E.S. and Kulkarni, G.S. (1913). Colocasia blight caused by *Phytophthora colocasiae. Agric. India,* **5:** 233-261.
4. Misra, R.S. (1996). A note on zoosporogenesis in *Phytophthora colocasiae. Indian Phytopath*. **49**(1):80-82.
5. Misra, R.S. (1997). Disease of tuber crops in Northern and Eastern India. *Technical Bulletin Series:* **22.** CTCRI, Kerala. India: 5-29.
6. Okpul, T., Ivancic, A. and Simin, A. (1997). Evaluation of leaf blight resistant taro (*Colocasia esculenta*) varieties for Bubia, marobe province, Papua New Guinea, *Popua New Guinea J. Agric. Forestry & Fisheries,* **40**(1-2): 13-18.
7. Prasad, S.M. (1982). National survey for diseases of tropical tuber crops. Regional centre of CTCRI, Bhubaneswar, (India): 49.
8. Shukla, Nandani (2006). Management of colocasia blight caused by *Phytophthora colocasiae* Racib. *M.Sc. (Ag). Thesis* submitted to NDUA & T, Faizabad. (U.P.)
9. Singh, H.K., Gupta, Savita and Singh, P.K. (2004). Field evaluation of colocasia genotypes against *Phytophthora* leaf blight. *Farm Sci. J.,* **13** (1) : 75-76.
10. Sugha, S.K. and Gurung, Kusum (2007).Evaluation of taro (*Colocasia esculenta*) germplasm against leaf blight (*Phytophthora colocasiae*). *India J. Agril. Sci.,* **77** (2): 68-70.
11. Thankappan, M. (1985). Leaf blight of taro-a review. *J. Root Crops,* **11**(1&2): 1-8.
12. Trujillo, E.E. (1967). The effect of humidity and temperature on *Phytophthora* blight of taro. *Phytopath.,* **55:**183-188.
13. Yadav, R.K., Yadav, D.S., Sanwal, S.K. and Sarma, Prnabjyoti (2006). Reaction of colocasia genotypes against leaf blight under Meghalaya condition. *India J. Agril. Sci.*. **76**(12): 770-772.
14. Yadav, V.K. and Aggarwal, A.P. (2008). Screening of germplasm of colocasia against *Phytophthora colocasiae*. *Ann. Pl. Prot. Sci.,* **16** (1): 261.

HortFlora Research Spectrum, 1(2): 187-189 (2012) ISSN : 2250-2823

Research Note :

POPULATION DYNAMICS OF ORIENTAL FRUIT FLY, *Bactrocera dorsalis* (Hendel) IN RELATION TO ABIOTIC FACTORS

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Keywords: *B. dorsalis, population dynamics,correlation,meteorological factors.*

Fruit flies are the most serious pest of fruits and vegetables not only in India but also all over the world. Fruit fly in India causes annual losses estimated as Rs. 2945 crore in mango, citrus, guava and sapota. As per the recent reports they cause upto 44% damage in guava orchards (Stonehouse *et al.* 6). Mango and guava are two important fruit crops which are severely damaged by fruit flies. Most common species attacking these two fruits are *Bactrocera dorsalis* (Hendel), *B. correcta* (Bezzi) and *B. zonata* (Saunders) (Verghese and Sudha devi, 7). Among the various alternate strategies available for the management of fruit flies , the use of methyl eugenol trap stands is the most outstanding alternative. Methyl eugenol has both olfactory as well as phagostimulatory action and is known to attract fruit flies from a distance of 800 m. Methyl eugenol, when used together with an insecticide impregnated into a suitable substrate, forms the basis of male annihilation technique. Therefore, the present research work was aimed to study the population dynamics of fruit flies and establish correlation between trap catch and meteorological parameters.

The experiments were conducted during two consecutive year (2005-06 and 2006-07) in the different orchards of the block Kakori of the distt. Lucknow. The fruit flies trapped in these traps were collected at weekly intervals starting from 10th standard week of 2005 to 9th standard week of 2007. The methyl eugenol traps used were transparent 2000 ml soft drink bottle traps. Each bottle trap had three windows of equal size and a wooden piece of 5 x 5 cm charged with 6 : 4 : 1 (alcohol:methyl eugenol: malathion) placed in a loop of plastic wire. These wooden pieces were recharged at monthly interval, replicated thrice. These pieces were then, dried in shade and hung inside the bottle with the help of plastic thread. Observations on mean number of fruit flies trapped in the traps were correlated with weather parameters viz., maximum temperature, minimum temperature, relative humidity and rainfall.

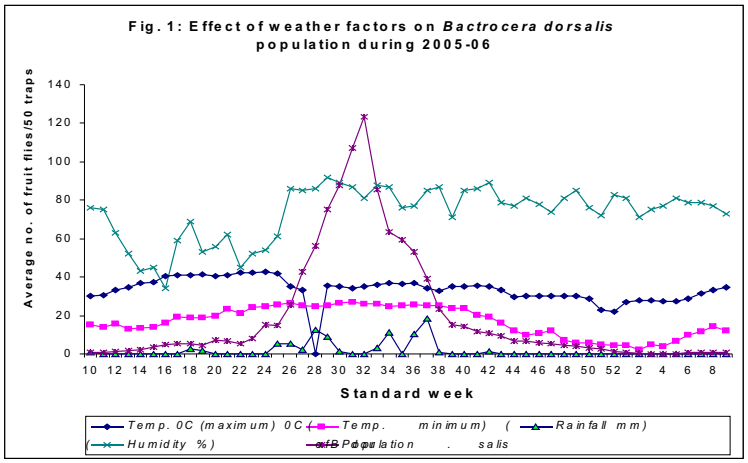
Population fluctuation

In the present investigation *B. dorsalis* was recorded as the most abundant species. The observed data in the Ist and 2nd experimental years revealed that the *B. dorsalis* population showed its peak in 32nd and 35th SW, respectively (Fig 1 & 2). This finding is supported by Gupta and Bhatia (2) who reported maximum *B. dorsalis* population during 30th SW of 1992 in mango orchard. Rajitha (4) also observed the peak incidence of *B. dorsalis* during 30th standard week in guava orchard. Deepa *et al.* (1) reported peak of *B. dorsalis* during fourth week of April, which supports the present study.

Correlation between *B. dorsalis* and weather factors

The data recorded on the *Bactrocera dorsalis* population was studied during two consecutive years *i.e.,* 2005-06 and 2006-07. Correlation between *B. dorsalis* and weather conditions resulted in a non-significant correlation with maximum temperature while it showed positive significant correlation with minimum temperature,

Received : 31.1.2012 *Accepted : 5.3.2012*



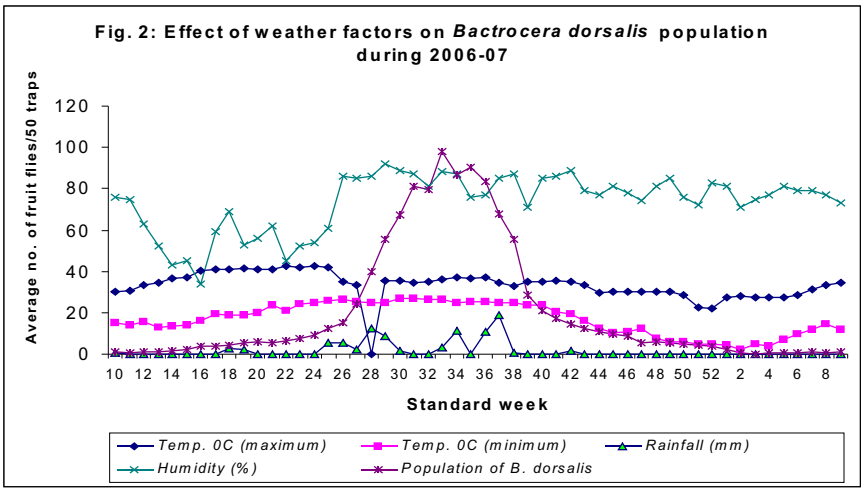


Table 1: Coefficient of correlation (r) between trap catches of *Bactrocera dorsalis* and meteorogical parameters.

Meteorogical parameters	*Bactrocera dorsalis*	
	2005	**2006**
Maximum Temperature	0.20	0.21
Minimum Temperature	0.65**	0.63**
Relative Humidity	0.42**	0.53**
Rainfall	0.40**	0.34*

* Significant at 5% level of difference = 0.273; ** Significant at 1% level of difference = 0.354

relative humidity and rainfall in both years of the experimen (Table 1).

Rajitha and Viraktamath (5) found *B. dorsalis* having significant positive correlation with minimum temperature and morning and afternoon relative humidity. The findings of Rajitha and Viraktamath (4) were more or less reported similar results but they noticed the *B. dorsalis* population with significant positive correlation with minimum temperature and relative humidity, whereas a negative correlation with maximum temperature.

The finding of Rai *et al.* (3) are in full

agreement with the present results. They also found positive correlation with temperature, relative humidity and rainfall against *B. dorsalis.*

REFERENCES

1. Deepa M., Agrawal Neerja, Viswakarma Rahul, Kumari, Kiran and Lal, K. Mitali (2009). Monitoring and weather parameters on *Bactrocera* complex through methyl eugenal traps. *Ann. Pl. Protec. Sci.,* **17**(2): 332-336
2. Gupta, D. and Bhatia, R. (2000). Population fluctuations of fruit flies *Bactrocera spp*. in submountainous mango and guava orchard. *J. Appl. Hort.*, **2 :** 47-49.
3. Rai, S., Shankar, U., Bhagat, R. M. and Gupta, S.P. (2008). Population dynamics and succession of fruit fly on sub-tropical fruits under rainfed condition in Jammu region. *Indian J. Entom.,* **70** (1): 12-15
4. Rajitha, A.R. (2004). Monitoring of fruit flies using different types of traps and lures in guava and mango. *M.Sc. (Agri.) Thesis*, University of Agricultural Sciences, Dharwad
5. Rajitha, A.R. and Viraktamath, S., (2006). Monitoring fruit flies (Diptera : Tephritidae) in guava orchard in Dharwad, Karnataka. *Karnataka J. Agric. Sci.,* **19:** 35-39.
6. Stonehouse, J.M., Riaz Mahmood, Ashraf Poswal, John, Mumford and Karim, Nawaz (2005). Studies on economically important fruit flies in Pakistan. *Crop Protec.,* **21** (8) : 661-669.
7. Verghese, A. and Sudhadevi, K. (1998). Relation between trap catch of *Bactrocera dorsalis* Hendel and abiotic factors In : *Proceedings of first National symposium on pest management in Horticultural crops* Bangalore pp. 15-18.

HortFlora Research Spectrum, 1(2): 190-192 (2012) ISSN : 2250-2823

Research Note :

EFFECT OF NPK LEVELS ON GROWTH, YIELD AND QUALITY OF OKRA CV. ARKA ANAMIKA

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Keywords: *NPK levels, growth, yield, okra.*

Bhindi (okra), botanically known as [*Abelmoschus esculentus* (L.)Moench] belongs to family Malvaceae. Okra is an annual vegetable crop propagated from seed in tropical and subtropical regions of the world. After harvesting fruits can be easily transported in bulk and stored for few days with much loss of quality. Okra fruits are important and used as vegetable in India, Brazil, West Africa and many other countries. For the year round consumption sundried (Africa, India), frozen and sterilized (USA) fruits are also important market production. Tender green fruits are cooked in curry and are also used in soups. The root and stem are useful for clearing cane juice. Consumable unripe *bhindi* fruits contain 10.4 g dry matter, 3100 calorie energy, 1.8 g protein, 90 mg calcium, 1.0 mg iron, 0.1 mg carotene, 0.07 mg thiamine, 0.08 mg riboflavin, 0.08 mg niacin and 18 mg vitamin C with almost comparable constituents, barring a few, in the leaves, it has multiple uses. The dry seeds contain 13-22% edible oil and 20-24% protein. The seed can also used as an animal feed. The dry fruit shell and stem containing crude fibre are suitable to manufacture paper and cardboard.

Okra plants need NPK for optimum growth and yield. Application of deficient nutrients through fertilizers, if therefore necessary, under different agro-climatic conditions can be manipulated to maximized production from a unit land area. Normally the yield per unit area increases with increase in plant population up to certain critical level, after which the yield decreases due to the competition between the plant for light, space and nutrient.

Received : 20.2.2012 Revised : 26.2.2012 Accepted : 22.3.2012

The present investigation was carried out at Horticulture Research Farm of the Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University, Lucknow. The experiment was conducted during the year 2008-09 under Randomized Block Design with three replications. The observations were recorded on 13 yield and yield attributing traits viz. plant height (cm), no. of leaves/plant, no. of nodes/plant, stem diameter (cm), no. of days to flowering, no. of flowers/plant, days to first fruit formation, length of fruit (cm), diameter of fruit (cm), no. of fruits/plant, weight of fruit/plant (g), fruit yield/plot (kg) and fruit yield/hectare (q/ha). There were 10 treatment combinations of nitrogen, phosphorus and potash which were used to assess their effect on growth, flowering, yield and quality of okra.

Observations recorded on different yield and yield attributing traits (Table 1) revealed that application of nitrogen increased the height of plant significantly at final observation with increasing levels during experimentation. Treatment T_9 showed maximum plant height (106.58 cm) followed by T_8 (104.03 cm) and T_6 (102.02 cm), over control (T_0) to 90.67 cm. The maximum no. of leaves/plant was showed by T_9 (20.56) followed by T_6 (17.73). While, minimum no. of leaves was noted in control (9.56). The maximum no. of nodes/plant was reported in treatment T_9 (12.05) followed by T_3 (11.74) and minimum was recorded in control (8.01). Results are in conformity with Arjum and Amjab (1), Singh (5) and Verma *et al*. (6).

The diameter of main shoot of okra plants was

Table 1: Effect of different treatment combinations of NPK on growth and yield of okra.

Sl. No.	Treatments	Characters												
		Plant height (cm)	No. of leaves /plant	No. of nodes/ plant	Stem dia-meter (cm)	No. of days taken to flower-ing	No. of flower / plant	Days to first fruit forma - tion	Length of fruits (cm)	Diame ter of fruits (cm)	No. of fruits/ plant	Weight of fruits/ plant (g)	Fruit yield/ plant (kg)	Fruit yield /hect-are
1.	Control $N_0P_0K_0$ (T_0)	90.67	9.56	8.01	1.22	46.78	8.69	48.11	9.09	1.61	8.67	141.02	3.18	58.90
2.	($N_{60}P_{30}K_{30}$) $N_1P_1K_1$ (T_1)	92.93	14.15	9.07	1.79	46.50	8.87	47.30	9.90	2.10	8.89	167.90	3.24	60.05
3.	($N_{60}P_{60}K_{45}$) $N_1P_2K_2$ (T_2)	92.06	16.59	9.62	2.09	45.90	10.63	47.03	10.21	2.21	10.61	178.10	3.46	64.22
4.	($N_{60}P_{60}K_{60}$) $N_1P_3K_3$ (T_3)	99.91	16.71	11.72	2.15	45.96	10.40	46.97	11.35	2.45	10.42	170.01	3.42	63.36
5.	($N_{90}P_{30}$ K_{30}) $N_2P_1K_1$ (T_4)	100.51	14.38	9.73	1.89	45.51	10.25	47.09	11.90	2.51	10.27	162.92	3.50	64.83
6.	($N_{90}P_{60}K_{45}$) $N_2P_2K_2$ (T_5)	102.02	16.94	10.21	1.99	43.69	11.65	46.09	14.02	2.81	11.63	181.09	3.52	65.09
7.	($N_{90}P_{90}$ K_{60}) $N_2P_3K_3$ (T_6)	102.02	17.73	11.23	2.11	43.80	11.35	46.71	14.85	2.60	11.38	190.21	3.61	66.91
8.	($N_{120}P_{30}K_{30}$ $N_3P_1K_1$) (T_7)	100.81	15.58	9.64	1.99	47.90	11.28	47.18	12.00	1.98	11.25	160.81	3.51	65.00
9.	($N_{120}P_{60}K_{45}$ $N_3P_2K_2$) (T_8)	104.03	16.86	10.38	1.96	47.56	10.91	46.65	11.91	2.61	10.90	172.01	3.55	65.70
10.	($N_{120}P_{90}K_{60}$) $N_3P_3K_3$ (T_9)	106.58	20.56	12.05	2.26	43.08	12.50	46.05	15.10	2.71	12.51	209.56	3.82	70.81

recorded at 80 days after sowing. Observation indicated beneficial effect of nitrogen levels right from initial stage of plant growth. Treatment T_9 (2.26 cm) showed maximum diameter of stem. The lowest diameter of stem was noted with control (1.22 cm). The earliest flowering was recorded in T_9 (43.08 days) followed by T_5 (43.69 days). It is clear from the mean value presented in Table 1 that increasing levels of N_2, P_2O_5 and K_2O increased the number of flower formation significantly. The maximum no. of flowers/plant was recorded in T_9 (12.51) followed by T_5 (11.65). The maximum length of fruit was recorded in treatment T_9 (15.10 cm) followed by and T_6 (14.85 cm) and the thickest fruit was reported in treatment T_5 (2.81 cm) followed by T_9 (2.71 cm). The least girth of fruit was reported in control (1.61 cm). The maximum no. of fruits/plant was recorded in T_9 (12.51) followed by T_5 (11.63) and T_6 (11.38) while minimum was reported in control (8.67). Similar findings have also been reported by Chauhan and Gupta (2) and Mishra and Pandey (3).

The maximum weight of fruits/plant was recorded under treatment T_9 (209.56 g) followed by (190.21 g). The least weight of fruits/plant was recorded in control (141.02 g). The maximum weight of fruits/plot was found under treatment T_9 (3.82 kg) followed by T_6 (3.16 kg) while least was reported in control (3.18 kg). The maximum fruit yield was reported under treatment T_9 (70.81 q/ha) followed by T_6 (66.91 q/ha). The lowest fruit yield per hectare was reported in control (58.90 q/ha). Results are in line with findings of Singh and Srivastava (4) and Verma *et al.* (6).

On the basis of overall performance under present investigation, it may be concluded that the application of recommended dose of NPK (120 : 90 : 60 kg/ha) resulted the higher yield of okra in respect of various quantitative and qualitative traits.

REFERENCES

1. Arjum, M.A. and Amjab, M. (1999). Response of Okra [*Abelmoschus esculentus* (L)] to different levels of N, P and K fertilizers. *Pak. J. Sci.,* **2** (3):794-796.
2. Chauhan, D.S. and Gupta, M.L. (1973). Effect of nitrogen, phosphorus and potash on growth and development of Okra [*Abelmoschus esculentus* (L.) Moench]. *Indian. J. Hort.,* **30** (1-2): 401-406.
3. Mishra, H.P. and Pandey, R.G. (1987). Effect of N and K on the seed production of Okra (*Abelmoschus esculentus* (L.) Moench), in calcarius soil. *Indian J. Agron.,* **32** (4):425-427.
4. Singh, K. and Srivastava, B.K. (1988). Effect of various levels of nitrogen and phosphorus on growth and yield of chilli (*Capsicum annuum* L.) *Indian J. Hort.,* **45**(3-4):319-344.
5. Singh, N.P. (1979). Effect of nitrogen, phosphorus and potassium on bhindi (*Abelmoschus esculentus* (L.) Moench). *Prog. Hort.,* **10**(4):21-30.
6. Verma, V.K., Pundrik, K.C. and Chauhan, K.S. (1970). Effect of different levels of nitrogen and phosphorus on yield of Okra (*Abelmoschus esculentus* (L.) Moench). *Punjab Hort. J.*, **10:**130-136.

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2. Johnson D.A. (1940). *Plant Microtechnique*. McGraw- Hill Publishing Co. Ltd., New York.pp-29
3. Kapil R.N. and Arora S. (1990). Some fascinating features of orchid pollen. *J. Orchid Soc.*, **4** (1): 9-28.
4. Rashid S., Ashraf M., Bibi S. and Anjum R. (2000). Antibacterial and antifungal activities of *Launaea nudicaulis* Roxb. and *Launaea resedifolia* L. *Pakistan J. Biol. Sci.*, **3** (4) :630-632.

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